

COPPER RESOURCES OF CALIFORNIA

U.S. GEOLOGICAL SURVEY

1942

CALIFORNIA STATE MINING BUREAU
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CALIFORNIA

By N. F. DRAKE,

Department of Geology, Leland Stanford Jr. University.

Accompanying Bulletin No. 23.

The Copper Resources of California,

ISSUED BY THE

STATE MINING BUREAU,

FERRY BUILDING,

SAN FRANCISCO.

LEWIS E. AUBURY,

State Mineralogist.



—equal/ Value—

ASSEMBLY, 1863

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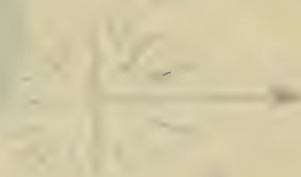
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SEAFACED HEMATITE FROM IRON MOUNTAIN MINE, SHASTA COUNTY.

CALIFORNIA STATE MINING BUREAU.

FERRY BUILDING, SAN FRANCISCO.

BULLETIN No. 23.

San Francisco, April, 1902.

THE *Walter W. Bradie*

COPPER RESOURCES

OF CALIFORNIA.

By
LEWIS E. AUBURY,
State Mineralogist.

By authority of
HENRY T. GAGE, *Governor of California.*

COMPLIMENTS OF
W. H. STORMS
STATE MINERALOGIST

SECOND EDITION.



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CONTENTS,

	PAGE.
CONDITION OF THE INDUSTRY - - - - -	9
HISTORICAL NOTES - - - - -	23
SHASTA COUNTY - - - - -	39
THE COPPER BELT - - - - -	43
GEOLOGY OF THE COPPER BELT - - - - -	53
SHASTA COUNTY COPPER MINES - - - - -	66
COAST RANGE DEPOSITS - - - - -	97
SISKIYOU COUNTY - - - - -	102
DEL NORTE COUNTY - - - - -	111
TRINITY COUNTY - - - - -	117
HUMBOLDT COUNTY - - - - -	126
TEHAMA, GLENN, AND COLUSA COUNTIES - - - - -	129
MENDOCINO COUNTY - - - - -	134
LAKE COUNTY - - - - -	138
NAPA COUNTY - - - - -	139
SONOMA COUNTY - - - - -	140
MARIN COUNTY - - - - -	143
ALAMEDA COUNTY - - - - -	144
MERCED COUNTY - - - - -	146
SAN BENITO COUNTY - - - - -	146
SAN LUIS OBISPO COUNTY - - - - -	147
THE SIERRA NEVADA COPPER BELT - - - - -	149
PLUMAS AND SIERRA COUNTIES - - - - -	152
NEVADA COUNTY - - - - -	162
YUBA COUNTY - - - - -	171
PLACER COUNTY - - - - -	172
EL DORADO COUNTY - - - - -	174
AMADOR COUNTY - - - - -	182
CALAVERAS COUNTY - - - - -	187
ALPINE COUNTY - - - - -	199
TUOLUMNE COUNTY - - - - -	200
MARIPOSA COUNTY - - - - -	203
MADERA COUNTY - - - - -	217

(3)

THE SIERRA NEVADA COPPER BELT—CONTINUED—	PAGE.
FRESNO COUNTY - - - - -	224
TULARE COUNTY - - - - -	233
KERN COUNTY - - - - -	237
SOUTHERN AND EASTERN DEPOSITS - - - - -	242
MONO COUNTY - - - - -	242
INYO COUNTY - - - - -	243
SAN BERNARDINO COUNTY - - - - -	249
RIVERSIDE COUNTY - - - - -	255
SAN DIEGO COUNTY - - - - -	259
LOS ANGELES COUNTY - - - - -	260
APPENDIX - - - - -	263
THE STATE MINING BUREAU - - - - -	263
CALIFORNIA MINERAL STATISTICS - - - - -	274

LIST OF ILLUSTRATIONS.

	PAGE.
Stalactitic Limonite from Iron Mountain Mine, Shasta Co. <i>Frontispiece.</i>	
Bully Hill Mines and Smelter, Shasta County - - - - -	11
Calcining furnaces of the Mountain Copper Company, Keswick, Shasta County - - - - -	13
Mountain Copper Company's Smelter, Keswick, Shasta Co. -	15
Surface mining plant of the Mountain Copper Company, in Slick Rock Cañon, with Iron Mountain at the right - - - - -	32
Blister copper from Bully Hill Smelter awaiting shipment -	33
Tunnel entrance at Sugar Loaf Copper Mine, Shasta County -	35
View of Bully Hill Copper Mines from the north - - - - -	47
Bully Hill, Shasta County, showing original tunnel opened in 1863 -	49
Geological sections according to available data, etc. - - -	59
Sketch showing ore deposits of Iron Mountain Mine - - - -	62
Sketch showing ore bodies of Balaklala and Shasta King Mines -	64
Smelter of the Mountain Copper Company, Keswick, Shasta Co. -	69
McDougal roasting furnace, Keswick Smelter, Mountain Copper Company, Shasta County - - - - -	71
Roasting stalls at Bully Hill Smelter, Shasta County - - -	76
Smelter at the Bully Hill Mines, Shasta County - - - - -	77
Chute between Tunnels Nos. 2 and 3, electric power house and tim- ber sheds, Bully Hill Mines - - - - -	79
View of Bully Hill Smelter from mouth of No. 3 Tunnel - - -	79
Shasta King Mine of the Trinity Copper Company, Shasta Co. -	83

LIST OF ILLUSTRATIONS.

5

	PAGE.
Gossan croppings and tunnel, Balaklala Mine Shasta Co. -	85
Ore dump and tunnel, Mammoth Copper Mine, Shasta Co. -	89
Oom Paul Claims, gossan croppings, Shasta County - -	91
Blue Ledge group of copper mines, Siskiyou County - -	108
Preston Peak group of copper mines, Siskiyou County -	110
Low Divide District, Del Norte County - - - -	113
Granite Group, Trinity County - - - - -	121
Croppings 60 feet wide, Island Mountain Copper Mine - -	123
Croppings 130 feet wide, Island Mountain Copper Mine -	123
Boulder of copper ore 60 feet across base, 30 feet deep, 25 feet across top, Island Mountain Copper Mine, Trinity County - -	125
Boulders of copper ore on north bank of Eel River, from outcrop 500 feet distant, Island Mountain Copper Mine, Trinity Co. -	125
Gray Eagle Copper Claim, Colusa County - - - -	133
Redwood Copper Queen Mine, Mendocino County - -	137
Copper croppings, Williams Claims, Genesee, Plumas County -	157
Mountain on which is located the Duncan group of copper mines, Genesee, Plumas County, near Flournoy's - - -	157
Ideal cross-section of Spenceville formation - - -	164
Plant of the Spence Mineral Company, Spenceville - -	165
Sketch map of Mineral Hill group of mines - - - -	168
Cosumnes Copper Mine, El Dorado County - - - -	179
Contraband Tunnel, El Dorado County - - - -	179
Union Copper Mine, Copperopolis, Calaveras County - -	191
Penn Copper Mining Company's Mine, at Campo Seco - -	195
Smelting works of the Penn Mining Company, Campo Seco -	195
Napoleon Copper Mine, Calaveras County - - - -	196
Green Mountain Copper Mine, Mariposa County - -	205
Dump of the Green Mountain Copper Mine, Mariposa County -	205
At the Green Mountain Copper Mine, Mariposa County -	207
Lone Tree Mine, Mariposa County - - - - -	207
Pocahontas Copper Mine, Mariposa County - - - -	209
White Rock, Mariposa County - - - - -	211
White Rock Mine, Mariposa County - - - - -	211
La Victoria Mine, Mariposa County - - - - -	214
Buchanan Copper Mine, Madera County - - - -	219
California Copper Company's property, Daulton ranch, Madera County - - - - -	221
California Copper Company's Smelter, at Madera - - -	223
Mining plant of the Copper King Mining Company, limited, Fresno County - - - - -	227
Shipping station of the Copper King Mining Company, limited, at Deering, on S. P. R. R. - - - - -	229
Smelter of the Copper King, limited, at Seal Bluff Landing, Contra Costa County - - - - -	229
Converter furnaces in course of erection, Copper King, limited, Seal Bluff Landing, Contra Costa County, - - -	231
Copper Mountain Mining Company's claims, Tulare County -	235

	PAGE.
Greenback Copper Mine, Kern County - - - -	239
Vertical section through stope in Greenback Copper Mine -	240
Croppings of Copper King Mine, Ubehebe District, Inyo Co. -	247
Copper croppings at Dodd's Springs, Ubehebe District, Inyo Co. -	247
Ferry Building, San Francisco, one half the upper floor of which is occupied by the State Mining Bureau . - -	264
Mineral Museum, California State Mining Bureau - - -	266
Library and free reading-room, California State Mining Bureau	267
Laboratory, California State Mining Bureau - -	269
Draughting Department, California State Mining Bureau -	271

- MAPS (FOLDERS).

Relief map of California.

Map showing location of the copper deposits of California.

Map of a portion of the Shasta County Copper Belt east of the
Sacramento River.

Map of the Shasta County Copper Belt west of the Sacramento River.

Geological map of the western portion of the Shasta County Copper Belt.

Geological map of the east-central portion of the Shasta County Copper
Belt.

Island Mountain Consolidated Copper Mines, Trinity County.

Green Mountain Group of Mining Claims, Mariposa County.

LETTER OF TRANSMITTAL.

To His Excellency, HENRY T. GAGE, Governor of the State of California, and the Honorable Board of Trustees of the State Mining Bureau:

GENTLEMEN: I have the honor to transmit the results of a portion of the recent work of the State Mining Bureau as embodied in Bulletin No. 23, entitled "The Copper Resources of California."

This is the first of a series of bulletins on special features of the mining industry of California to which the energies of the State Mining Bureau have been largely turned during the current fiscal year, and the first to be completed of the four for which material has so far been gathered. The great and slightly realized extent of the copper resources of California, the new activity which has recently come to the copper industry of this State, and the great possibilities and promise of its future, make timely and appropriate the attention here given to our mineral product of second rank.

The purpose which has guided the field and office work of which this bulletin is the product has been primarily that of setting forth the practical and economic facts that could most readily afford to the people of the State, and to others elsewhere, a comprehension of the extent of our copper resources, the condition and prospects of our copper industry at this early stage of its development, and the opportunities open to capital and enterprise. In pursuance of this policy, the purely scientific and technical phases of the subject have been given but small and incidental attention. The value that would attach to the results of special research in the geology and mineralogy of the widely distributed and much varied copper deposits of the State,

and to expert expositions of technical features, is fully recognized, but a fair apportionment of the time and resources of the Bureau did not permit the work to take this direction. What has been sought is to give a general understanding of the status and significance of the copper industry and a brief descriptive account of the principal copper mines and prospects that seem worthy of present attention. It is hoped that the chief object of this bulletin, that of stimulating the development of our copper resources by both home and foreign enterprise, will be in a measure gained.

The field work on this bulletin began in July, 1901. During the succeeding months, field assistants visited every county in the State. Every facility was granted the assistants in making inspection of mines and prospects, except at a few of the larger properties, and the obtaining of necessary information regarding the latter and of supplementary information along various lines caused the issuance of the bulletin to be delayed somewhat. The assistants who have gathered the data here presented were P. C. DuBois, F. M. Anderson, J. H. Tibbits, G. A. Tweedy, Marion Aubury, and J. O. Denny.

Very respectfully,

LEWIS E. AUBURY,

State Mineralogist.

April 5, 1902.

Walter W. Bradley.

THE COPPER RESOURCES OF CALIFORNIA.

CONDITION OF THE INDUSTRY.

Copper has recently risen to the place of second importance in the annual record of California's mineral production, and has assumed a new and large significance in the industrial life of the State. With an output of 34,931,985 pounds, valued at \$5,501,782, in 1901 California is the fourth copper-producing State of the Union. While Michigan, Montana, and Arizona very greatly exceed this output, the figures of the world's production show California to be one of the important sources of the world's copper supply, and an intelligent measure of the copper resources of California and of the condition and prospects of the copper industry shows that the State will undoubtedly soon assume a much larger importance as a copper field and that it will long remain a strong factor in the industry.

The copper industry is an old one in California. Many thousands of tons of rich ores were shipped for reduction from San Francisco to the Atlantic Coast and Europe between 1861 and 1868; but thereafter for many years the industry remained at a low ebb, and copper was one of the minor mineral products of the State. In 1896 came the discovery of the possibilities of the large copper belt in Shasta County, the result of the opening and successful operation of the mine of the Mountain Copper Company in Iron Mountain. This mine soon took high rank among the great copper mines of the world, and its output is now exceeded by but six mines in the United States and by but eight in the world. The further exploitation of the Shasta County copper belt soon followed the early success of the Mountain Copper Company, and in 1901 another great

property, the Bully Hill, entered the field as a producer, equipped with a modern smelting plant. Its reduction facilities and output are expected to be doubled during 1902, when the product of the Bully Hill is likely to equal that of Iron Mountain.

The Mountain Copper Mine is the only new mine in the world with a very large output that has become a producer within nearly a decade, and the Bully Hill promises to soon achieve a similar distinction. Two or three other properties of this belt are now undergoing exploitation, with prospects of becoming large producers within two years. In other parts of the State are several smaller producing mines, and quite a number that are undergoing development promise to contribute more or less to the State's output in the future. California's copper resources thus command interested attention at the present time, not only because of their relation to the material prosperity of the State, but because of their wider significance as a comparatively new and a very important source of the world's copper supply.

California's copper deposits have a remarkably wide distribution, being scattered over the length and breadth of the State and occurring in practically every one of its fifty-seven counties. Thousands of deposits have been subjects of mining locations at different times, and hundreds have yielded at least a few tons of merchantable ore as a result of superficial prospecting. There is hardly a county in the State which has not at some time made at least such small contributions to the copper supply. Such deposits, usually small as far as revealed by slight development, are scattered at varying intervals along the borders of the State and throughout every section of it, except in the detrital deposits of the valleys.

The deposits of economic importance, however, are mainly concentrated in certain belts and districts which require chief consideration. For convenience, the copper deposits of the State are in this bulletin grouped in four geographical divisions: Shasta County; the Coast Range; the Sierra Nevada range; and the general arid region of southeastern California.

The leading copper district of California, and the one that promises to remain of overshadowing importance for a good while in the future in total output of metal, is that of Shasta County, in the north-central part of the State. Here is a



BULLY HILL MINES AND SMELTER, SHASTA COUNTY.

series of copper deposits forming a curved belt nearly 30 miles long, and a copper district which must soon rank with the few great individual copper districts of the world.

Of second importance is the copper belt of the western slope of the Sierras, which in territorial magnitude is not rivaled in the world. Here is an almost continuous series of copper deposits stretching north and south for about 400 miles. In this belt the principal copper mines of the State in former years were developed, and along it there will undoubtedly be many producing mines developed in the future.

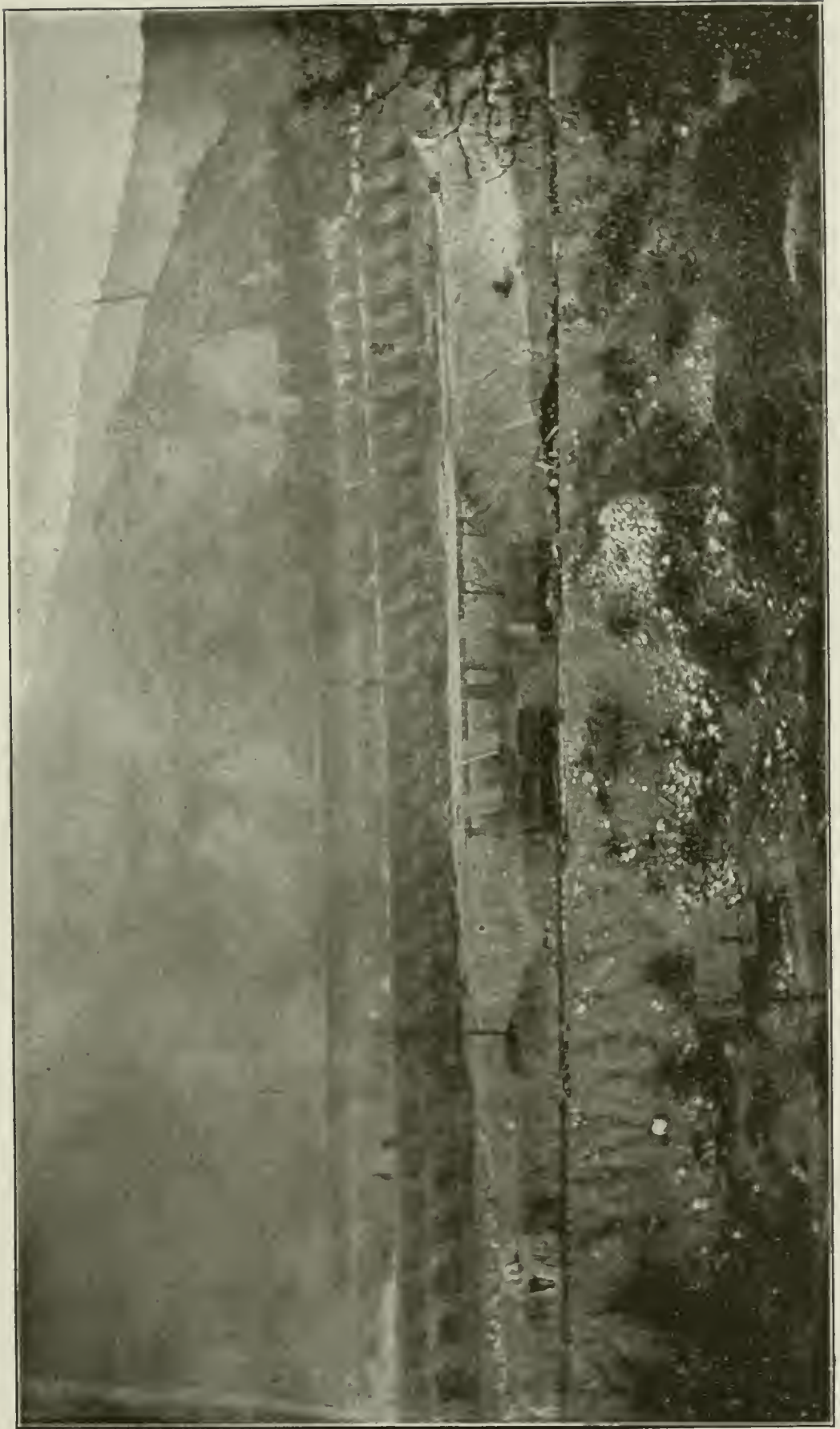
While the Coast Range displays copper deposits throughout its length of 500 miles, its important copper districts are in its northern portion, extending for about 150 miles southward from the Oregon line. Except in Del Norte County, in the northwestern corner of the State, where several mines were productive of considerable quantities of shipping ore nearly forty years ago, the deposits of this range have not been developed beyond the most superficial prospecting in a few instances, but surface indications point to the widespread existence of cupriferous veins of sufficient size and value to warrant development and the expectation that this great mineral region will include profitable copper mines among its industries.

Many copper deposits are widely scattered throughout Southern California, especially through the mineralized desert region of the southeastern part of the State. These deposits much resemble those of Arizona in their character.

THE COPPER ORES.

The principal commercially useful copper ores found in California are the sulphides, carbonates, and silicate of copper. The most common of these, and the one that may virtually be found throughout the entire mineral belt of California, is

Chalcopyrite.—Sometimes designated as copper pyrite. This mineral is a double sulphide of copper and iron, of a brass yellow color, giving a greenish-black streak. It has a hardness of 3.5 to 4 in the mineral scale, and a specific gravity of 4.1 to 4.3, with a metallic luster which is sometimes tarnished, showing iridescence. It is usually auriferous and argentiferous. It is found, both in crystal form and massive,



CALCINING FURNACES OF THE MOUNTAIN COPPER COMPANY, KESWICK, SHASTA COUNTY

in gneiss, crystalline schists, serpentine, etc., associated with iron pyrite, zinc blende, quartz, calcite, and barite (heavy spar). It is composed, when pure, of copper 34.6, iron 30.5, and sulphur 34.9.

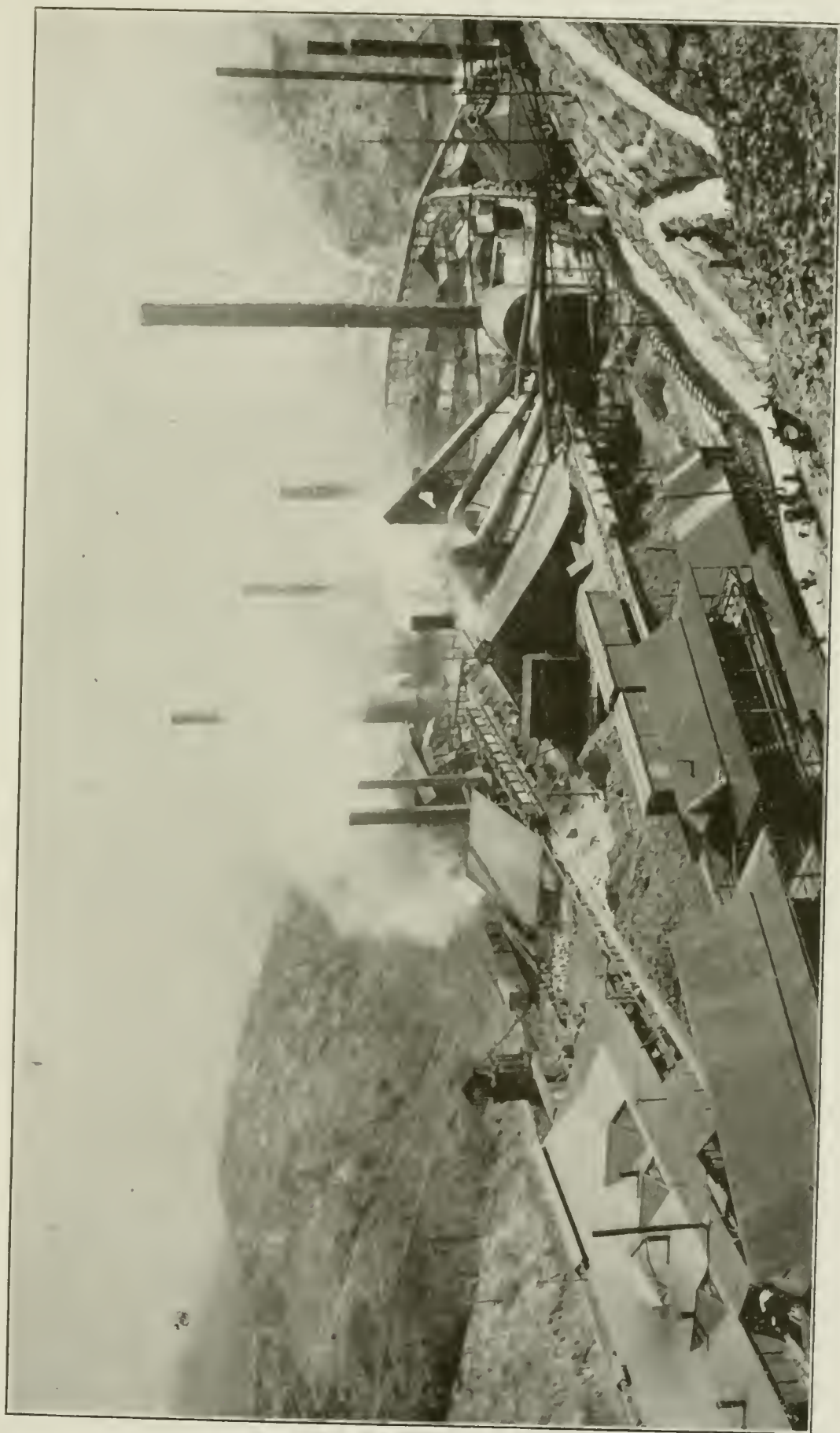
Bornite.—Also known as erubescite, horseflesh ore, peacock ore; is, like the former, a double sulphide of copper and iron, of a metallic luster, with a purple red to pinchbeck brown color on a fresh fracture, tarnishing speedily to iridescence. It gives a pale grayish-black streak. It has a hardness of 3 and specific gravity of 4.9 to 5.4, and contains copper 55.5, iron 16.4, sulphur 28.1. It has been found in Plumas, Fresno, Shasta, Santa Clara, Calaveras, and Inyo counties.

Chalcocite.—Copper glance; is a sulphide of copper, of a dark lead-gray color, often green on the surface, with a metallic luster and blackish lead-gray streak, often tarnished blue or green. The hardness is 2.5 to 3, and specific gravity 5.5 to 5.8. It contains 79.8 copper and 20.2 sulphur, with sometimes a little iron and silver replacing part of the copper. It has been found in Inyo, San Bernardino, San Diego, Los Angeles, San Luis Obispo, and Plumas counties.

Covellite.—Is a cupric sulphide, of an indigo blue or darker color, with a lead-gray to black shining streak, and sub-metallic luster when crystalline, but dull when massive. The hardness is 1.5 to 2, and specific gravity 4.59 to 4.63. It contains 66.4 copper and 33.6 sulphur. This ore is the result of alteration from other copper ores, especially chalcocite. It has been found in a few localities in California.

Azurite.—Is a hydrous carbonate of copper, of an azure blue color, vitreous luster and a light blue streak. The hardness is 3.5 to 4, and specific gravity 3.77 to 3.83. It is transparent to subtranslucent. This is a valuable copper ore, and is found in Calaveras, Inyo, and Monterey counties. It carries 69.2 copper oxide, 25.6 carbonic acid, and 5.2 water.

Malachite.—Is the green carbonate of copper; the color is bright green, giving a pale green streak; the hardness is 3.5 to 4, and specific gravity 3.9 to 4. It is found commonly massive, but also incrusting, with a delicate fibrous silky structure. It contains 19.9 carbon dioxide, 71.9 cupric oxide, and 8.2



MOUNTAIN COPPER COMPANY'S SMELTER, KESWICK, SHASTA COUNTY.

water. It is a valuable copper ore, and when found massive is used for ornamental purposes. It is found in numerous parts of California, but hitherto not massive.

Cuprite.—Red oxide of copper; is an oxide of copper of various shades of red, from cochineal red to almost black. It has an adamantine or submetallic to earthy luster, and a brownish red, shining streak. The hardness is 3.5 to 4, and specific gravity 5.85 to 6.15. It contains 88.8 copper, 11.2 oxygen, and is a common mineral in California, having been found with native copper in Del Norte and Plumas, also near St. Helena in Napa County, further in Kern, Tulare, Shasta, Mono, Colusa, Placer, Trinity, and Nevada counties.

Native Copper.—This is pure copper, containing often some silver, bismuth, mercury, etc. The color is copper red, giving a metallic shining streak, and showing a metallic luster. It has a hardness of 2.5 to 3, and a specific gravity of 8.8 to 8.9; and is found rather sparingly in California accompanying the various other copper ores, especially in the vicinity of igneous rocks, although it is also found in clay slates and sandstones. It has been found in Calaveras, Plumas, Amador, Santa Barbara, and Shasta counties.

Chrysocolla.—This mineral is a silicate of copper, with an opal-like or enamel-like texture. It varies in color, passing from a mountain green and bluish green to sky and turquoise blue; if impure, it may be brown to black. It has a vitreous, shining luster, and the streak (when pure) is white. The hardness varies from 2 to 4; the specific gravity is 2 to 2.238. As it is an alteration product, it is found in connection with other copper minerals, more especially in the southern portion of the State, though very handsome specimens have been found in Plumas County. It contains 45.2 copper oxide, 34.3 silica, and 20.5 water. It is a good copper ore.

Among the less frequent copper ores found in California we may note:

Melaconite.—Black oxide of copper. It is formed by decomposition of chalcopyrite and other copper ores. It is found earthy black, massive, with a specific gravity of about 5, and consists of 79.8 cupric oxide and 20.2 oxygen. It has been found in Calaveras, Shasta, and Kern counties.

Chalcanthite.—This is a native sulphate of copper (blue vitriol), and results from decomposition of copper sulphides. It occurs usually as an efflorescence in old copper mines. It has been found in California in the Peck mine, Shasta County; also in Lake and Nevada counties.

Tetrahedrite.—Gray copper ore (fahlore). This mineral has a gray to iron-black color and streak, with metallic luster, a hardness of 3 to 4.5, and a specific gravity of 4.4 to 5.1. It contains 23.1 sulphur, 24.8 antimony, and 52.1 copper. The antimony is sometimes replaced by arsenic, when the ore is named Tennantite. These ores frequently carry some silver.

STATISTICS.

The oldest consecutive record of the copper production of California having the stamp of official authority begins with 1882, when the United States Geological Survey began its mineral statistics. "Mineral Industry" began its annual mineral record with 1892. The California State Mining Bureau's careful yearly compilation of the amounts and values of the State's mineral products began in 1894. There are radical disagreements between the records of the U. S. Geological Survey and those of "Mineral Industry" as to some of the years succeeding 1891, and between these records and that of the State Mining Bureau as to some of the years succeeding 1893. The following statistical record of the copper product of California, in fine pounds, for 1882 and following years, is made up of the record of the U. S. Geological Survey for the years preceding 1894 and of the record of the State Mining Bureau for the succeeding years:

Year.	Fine Pounds.	Year.	Fine Pounds.
1882.....	826,695	1892.....	2,980,944
1883.....	1,600,862	1893 .. .	239,682
1884.....	876,166	1894	738,594
1885.....	469,028	1895.....	225,650
1886	430,210	1896.....	1,992,844
1887	1,600,000	1897.....	13,638,626
1888.....	1,570,021	1898.....	21,543,229
1889.....	151,505	1899.....	23,915,486
1890.....	23,347	1900.....	29,515,512
1891.....	3,397,405	1901.....	34,931,985

Table Showing the Copper Production of California by Counties for Seven Years from 1894.
Compiled from the Annual Mineral Statistics of the State Mining Bureau.

	1894.		1895.		1896.		1897.		1898.		1899.		1900.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amador			16,500	\$4,650	30,000	\$3,000			3,000	\$300			220,000	\$34,100
Calaveras	654,860	\$64,951	175,895	15,925	87,557	8,990	34,000	\$3,740	18,400	2,052	165,484	\$27,586	980,934	150,585
El Dorado													3 125	500
Inyo									49,829	3,986				
Kern													4,000	750
Madera													500,000	77,500
Nevada	83,728	7,535	33,255	3,325	28,200	2,820	12,000	960	30,000	3 000	43,438	7,084	150,980	20,472
San Bernardino											1,369,878	232,339	1,920,000	297,600
Shasta					1,847,087	184,708	13,592,626	1,535,966	21,442,000	2,465,830	21,385,863	3,565,023	25,736,473	4,166,735
Unapportioned											950,823	158,502		
Totals	738,594	\$72,486	225,650	\$21,950	1,992,844	\$199,518	13,638,626	\$1,540,666	21,543,229	\$2,475,168	23,915,486	\$3,990,534	29,515,512	\$4,748,242

California's Copper Production During the Fourteen Years Ending with 1900.

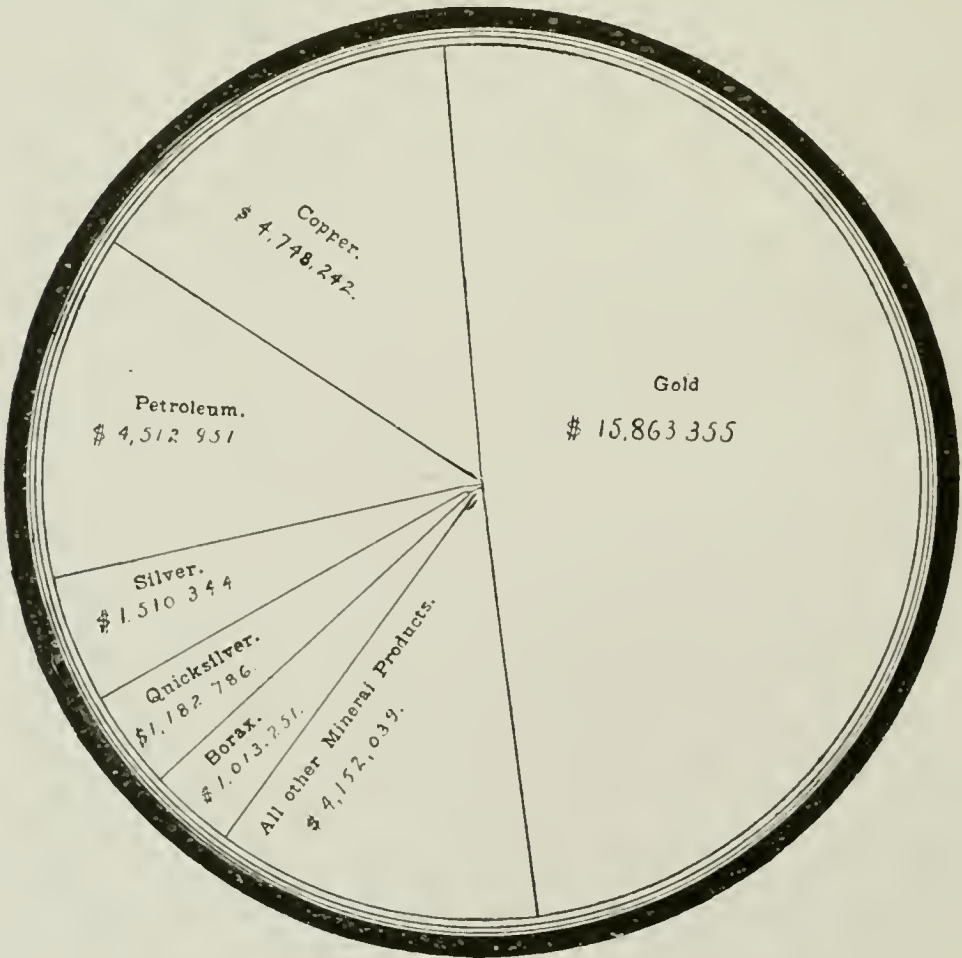
VALUE	YEAR	OUTPUT IN POUNDS
\$192 000	1887	1 600 000
235 303	1888	1 570 021
18 180	1889	151 505
3 502	1890	23 347
424 675	1891	3 397 455
342 808	1892	2 980 944
21 571	1893	239 682
72 486	1894	738 594
21 901	1895	225 650
199 519	1896	1 992 844
1 540 666	1897	13 638 626
2 475 168	1898	21 543 229
3 990 534	1899	23 915 466
4 746 242	1900	29 515 512

California's Copper Production in 1901, by Counties.

County.	Product, in Fine Pounds	Value.*
Alameda	13,728	\$2,162
Alpine	8,377	1,319
Amador	52,000	8,190
Calaveras	1,701,589	268,000
Fresno	1,159,672	182,648
Inyo	8,566	1,349
Kern	429,248	67,606
Madera	108,430	17,077
Mariposa	191,622	30,180
Merced	79,071	12,453
Mono	1,938	305
Nevada	39,588	6,235
Placer	11,200	1,764
Sacramento	2,007	316
San Bernardino	50,000	7,875
Shasta.	30,990,781	4,881,048
Stanislaus	79,330	12,494
Trinity	4,838	761
Total	34,931,985	\$5,501,782

* Values estimated at 15.75 cents per pound as the average price for the year at San Francisco.

Relative Proportions of the Total Values of Leading Mineral Products of California in 1900. Total Mineral Output, \$32,622,945.



The Progress of the Copper Industry in the United States, as shown by the Production by States, in pounds, in the years 1885, 1890, 1895, and 1900.

Source.	1885.	1890.	1895.	1900.
Lake Superior	72,147,889	101,410,277	129,330,749	145,461,498
Montana	67,797,864	112,980,896	190,172,150	270,738,489
Arizona	22,706,366	34,796,689	47,953,553	118,317,764
California	469,028	23,347	218,332	28,511,225
Utah	126,199	1,006,636	2,184,708	18,354,726
Colorado	1,146,460	3,585,691	6,079,243	7,826,949
Wyoming				4,203,776
New Mexico	79,839	850,034	143,719	4,169,400
Nevada	8,871			407,535
Idaho	40,381	87,243	1,425,914	290,163
South Dakota				15,147
Maine, New Hampshire, Vermont, Tennessee, and Southern and Middle States	442,449	378,840	3,105,036	4,820,495
Lead desilverizers, etc.	910,144	4,643,439		3,000,000
Total domestic copper	165,875,483	259,763,092	380,613,404	606,117,166
From imported ores and pyrites	5,086,841	6,017,041	5,300,000	36,380,000
Total	170,962,324	265,780,133	385,913,404	642,497,166

Average Annual Price of Lake Copper in New York since 1860.

Year.	Cents per lb.	Year.	Cents per lb.	Year.	Cents per lb.
1860.	22.25	1874	23.25	1888	16.66
1861.	19.12	1875	22.50	1889	13.75
1862	25.75	1876	21.00	1890	15.75
1863.	32.87	1877.	18.62	1891.	12.87
1864.	46.25	1878.	16.50	1892.	11.50
1865.	36.25	1879.	17.12	1893	10.75
1866.	31.75	1880.	20.12	1894	9.56
1867.	25.12	1881.	18.12	1895.	10.76
1868.	23.62	1882	18.50	1896	10.88
1869.	23.37	1883.	15.87	1897.	11.29
1870.	20.62	1884.	13.87	1898.	12.03
1871	22.62	1885	11.12	1899.	17.61
1872.	33.00	1886.	11.00	1900.	16.52
1873.	29.00	1887.	11.25		

Table showing the Position of Copper among the Principal Mineral Products of the United States in 1900.

Products Exceeding \$10,000,000 in Value.	Quantity	Value.
Coal	tons 263,735,265	\$306,891,364
Pig Iron, spot value	long tons 13,789,242	259,944,000
Copper, value at New York	pounds 606,117,166	98,494,039
Gold, coinage value	troy ounces 3,829,897	79,171,000
Silver, coinage value	troy ounces 57,647,000	74,533,495
Petroleum	barrels 63,362,704	75,752,691
Stone .....	.....	48,008,739
Lead, value at New York	short tons 270,824	23,561,688
Natural Gas .....	.....	26,606,463
Cement	barrels 17,231,150	13,283,581
Brick Clay .....	.....	12,000,000
Zinc, value at New York	short tons 123,886	10,654,196

Total value of all mineral products in 1900...\$1,067,605,587.

HISTORICAL NOTES.

The history of the copper industry of California is naturally divided into three periods. The first extended from 1860 to 1868, and was a period of active and widespread development and operation of copper mines, some of them on a considerable scale, and of the shipment of many thousands of tons of copper ores by sea to reduction works at Baltimore, New York, and Boston on the Atlantic coast, and to Swansea in Wales. The second period was one of depression and, in fact, of almost complete prostration, extending from the practical cessation of all development in 1868 to 1895. The third and present period is that beginning with the operations of the Mountain Copper Company in Shasta County in 1895, marked by the discovery and development of the immense ore bodies of the copper belt of Shasta County, and by a general revival of interest in the industry throughout the State as a consequence of the successes won at the north and of the recent period of high prices for the metal.

The widespread occurrence of copper in California had been known for many years before the industry began its productive career, but without attracting more than incidental attention. Old records state that as early as 1840 copper had been noted near Soledad Pass in Los Angeles County, and that about 1854 the deposits afterward worked there were discovered by a Frenchman named Maris. About 1855 a small deposit of copper ore was found in Hope Valley, Alpine County, by "Uncle Billy" Rodgers, and the specimens from it attracted considerable attention on account of their beauty and richness, but the discovery was soon forgotten. Dr. J. B. Trask, who acted as State Geologist from 1851 to 1854, discovered copper minerals in nearly every county in the State, but his reports thereon appear to have had no influence on the later beginning and progress of copper mining in California.

Available historical material is so fragmentary and often

unreliable and conflicting that the actual beginning of the industry can not be fixed. A valuable and lengthy paper in J. Ross Browne's official report on the Mineral Resources of the States and Territories West of the Rocky Mountains, made in 1867, identifies the beginning with the discovery of the Napoleon mine in Calaveras County, late in 1860, by Hiram Hughes. This is essentially an error, as other records show that several copper mining companies, mainly of Del Norte and Calaveras counties, were incorporated in that year, some of them in the spring. Langley's State Register for 1859 says, in part, regarding the copper resources of the State: "The ore from the vicinity of the Pitt and McCloud rivers, Shasta County, is said to excel in richness the celebrated Arizona mines, and to contain in addition a considerable quantity of gold. Ore of exceeding richness has also been found in different localities in El Dorado County, and a vein on the Cosumnes has yielded over seventy per cent of pure metal. There is a vein of copper on the middle fork of the Cosumnes River, Mountain Township, El Dorado County, now being worked by machinery propelled by water. The mill has three stamps attached, and has so far yielded a handsome return to the proprietors."

The last reference is believed to be to the old Cosumnes mine of that county, which was opened chiefly as a gold mine. The evidence indicates that, at the close of the decade of the fifties, practical attention was just turning to some of the known copper deposits of the State, and that modest plans for their exploration were being quietly formed.

However, that discovery by Hiram Hughes late in 1860 appears, from all historical data here available, to be entitled to the honor of being regarded as the real beginning of the notable period of copper mining that quickly ensued, because it does not seem to have resulted from what had been known or done before, and because the copper excitement of that day was a direct consequence of this and related discoveries. Mr. Hughes, according to J. Ross Browne's report, had lived and mined for gold for some years in the region of his discovery in the Gopher Hills, in the low foothills of the western end of Calaveras County. When the first Washoe excitement broke out he joined the rush to the famous new silver field of Nevada, and later joined the returning procession of the unsuccessful.

His observations of the Comstock lode had awakened his interest in rocks he had often seen near home, and on his return he began prospecting for silver. He found the gossan cap of what became the Quail Hill No. 1 mine, found it rich in gold, and began working it as a gold mine. Soon after he found the gossan of what was soon the Napoleon mine, and finding no gold, sent some of the ore to San Francisco for assay. It was reported to carry 30 per cent copper, and to be worth \$120 per ton. A local excitement broke out, the lode was traced and located for a number of miles, and hundreds of claims were staked out.

Among the local people who joined in the search for rich copper ores like those of the Napoleon, were W. R. Reed, Dr. Blatchly, and Mr. McCarty, who in June, 1861, made the important discovery and location of the Copperopolis lode, a few miles east of the Napoleon lode. McCarty had mined and farmed there in the Salt Spring Valley for ten years, and in 1852 had sunk a prospect shaft on the lode he now helped to locate. Finding no gold he quit, throwing away rich surface copper ores of what was to be the productive Keystone copper mine. Copper ores had in fact been familiar but worthless rocks to these local miners for many years. The men named located 11,250 feet of the Copperopolis lode, and the Copperopolis mine soon appeared richer than the Napoleon. New life was given the local copper excitement, and more hundreds of claims were staked out along and near the Copperopolis lode for twenty miles.

The copper excitement thus started quickly spread, and in a few months it filled the State, running its course after the natural manner of popular mining excitements, and expanding into adjoining States and Territories. The furor and speculative excitement lasted as such for about two years. Prospectors by hundreds visited Copperopolis, and went home or elsewhere to search for similar ores and formations.

The period of 1862-63 was marked by a speculative mania, the organization of hundreds of copper mining companies, and the wildcat exploitation of slight surface prospects. Copper operators soon realized the fact that money, skill, and legitimate development were necessary to success, and the boom suddenly burst, leaving legitimate mining companies to here and there throughout the State pursue their efforts to make

money from the development of mines and the shipment of ores. The following notes concerning the active period of the sixties are furnished by Thomas Price of San Francisco, a metallurgist who has been intimately associated with the California copper industry almost since its inception:

It was well on in the year 1861 before anything considerable had been done in the development of the newly discovered copper deposits of California, but at this time small shipments were made to Boston and Baltimore, and one small lot was sent to Swansea, Wales, by way of New York. By the spring of 1863 the shipments of copper ore from California to other parts of the United States and to Great Britain had assumed very considerable proportions.

During this period the most important copper mines were near the towns of Copperopolis, Campo Seco, and Lancha Plana, in Calaveras County, and the principal mines were the Union, Keystone, and Empire. The Union mine, the most extensively developed property in the State, was operated on a very considerable scale for several years, and from it several thousand tons of ore were shipped. The mine was opened up to a depth of something like 600 feet, and the vein of solid pyritic ore averaged about 14 feet in width, assaying from 12 to 25 per cent copper. In depth, however, the vein was found to be considerably mixed with slate, and the grade fell off from 6 to 8 per cent.

The mines at Campo Seco and Lancha Plana shipped several thousand tons of chalcopyrite ore, but the grade was not as high as in the mines near Copperopolis. Between 1863 and 1869 several hundred tons of ore were shipped from the Napoleon and Quail Hill mines, two mines situated some six miles to the west of Copperopolis. From near the surface to a depth of about 200 feet the ore in the Napoleon averaged 20 per cent copper. The Quail Hill yielded large quantities of carbonates and oxides of copper, and carried, in addition to the copper, considerable gold and silver. Several years after it had ceased to be worked as a copper mine, a forty-stamp mill was erected on the ground and an attempt was made to operate it as a gold and silver property, but the sanguine expectations of the owners were far from realized.

By stains and other indications the copper belt in Calaveras County can be traced for fully thirty miles, and during the early sixties literally thousands of claims were staked out along its course. There is no doubt but that systematic work would result in the development of many valuable copper properties along this belt, in addition to those now known and in process of exploitation.

In Amador County, the old Jackson, afterward known as the Newton mine, which was discovered in 1861, yielded, down to a depth of 200 feet, a high grade of chalcopyrite, running from 25 to 35 per cent copper, with small quantities of gold and silver. Several thousand tons of ore were shipped from this mine, most of which went to Great Britain; but as greater depth was attained the grade of ore decreased, and it ceased to pay for shipment under conditions and prices which then prevailed.

From the Newton mine the copper belt extended north to the

Cosumnes River, and near the river a low-grade deposit was opened up, but it proved too poor to stand the expense of shipment. Both Mariposa and Fresno counties, as then known, produced some copper ore. The Buchanan mine was the largest property in that section, and some hundreds of tons of ore were shipped from it.

Based upon the early day prospects, Tuolumne, Mariposa, Madera, Merced, Stanislaus, Fresno, and Tulare counties should prove large producers of copper when their resources in this direction shall have received proper attention. The Santa Cruz Mountains yielded several hundred tons of ore in the year 1867.

Earlier than this considerable very high-grade ore, carrying as much as 48 per cent copper, with 2 ounces of gold and 40 ounces of silver per ton, was shipped from Genesee Valley in Plumas County, the means of transportation being by teams to Marysville and thence by boat to San Francisco.

During the period extending from 1862 to 1865, Del Norte County ranked second only to Calaveras in the production of copper ore. The largest mine in Del Norte was known as the Low Divide, next to which came the Union, while the Occidental and other mines produced comparatively small quantities of ore. In Del Norte the copper belt extended north and south for a distance of about ten miles.

The old Zinc House mine, near the Empire ranch, in Nevada County, shipped considerable quantities of high-grade carbonates and oxides, but no large quantities of chalcopyrite, as in the case of most of the mines then shipping. The mine, however, contained large quantities of pyritic ore, but the percentage of copper contained was not sufficient to make it a shipping proposition. Subsequently this low-grade material was very successfully worked by open-air roasting, leaching, and precipitation of the copper on iron.

In Shasta County copper was discovered and mined at Copper City, then known as Williams, as early as 1862. In 1863 some 250 tons of the ore were shipped to San Francisco, but on sampling it was found to contain only 8 per cent copper, and was, therefore, of no value. On being assayed further, it showed a value of \$40 per ton in gold and \$20 in silver. It was shipped to Swansea, and gave a small margin of profit.

Small quantities of copper ore were shipped to San Francisco from Colusa County during the period from 1862 to 1864. Some of the ore mined from near the surface was very rich in copper, but the grade deteriorated very rapidly with depth.

It was well known in these early days that copper deposits existed in San Bernardino County and other southern counties, but their distance from shipping points rendered them valueless at that time.

During all this period the product of our copper mines had to be transported first to San Francisco and thence shipped to Boston, Baltimore, or Swansea. From 1862 to 1865 the price of copper ranged from \$4 to \$5 per unit; that is, an ore containing 20 per cent copper was worth from \$80 to \$100 per ton of 2376½ pounds, delivered at any of these three points. Nothing was paid for any gold in the ore below one ounce per ton, and from the silver contents a deduction was made of

three-fourths of an ounce for each one per cent of copper. After commencing to fall, the price of copper soon reached a point as low as \$3.20 per unit. It was this, coupled with the natural lowering of grade as depth was attained, which sank the copper industry of California into the profound slumber from which it is only just awakening.

The following *pro forma* statement of a shipment to Swansea may prove interesting at this time. The copper ton there is 21 hundredweight, or 2352 pounds, to which must be added, on foreign ores, $3\frac{1}{2}$ pounds draftage per 3 hundredweight, or $24\frac{1}{2}$ pounds per ton, making the ton, as reckoned, $2376\frac{1}{2}$ pounds.

Assay	21.30 per cent copper.
Less	1.30
Net	20.00 per cent.
100 tons (of $2376\frac{1}{2}$ lbs.), at \$5 per unit.....	\$10,000.00
Freight from mine to Stockton, at \$8 per ton of 2000 lbs.	\$950.40
Freight from Stockton to San Francisco, at \$1.25.....	142.76
Sampling and assaying, San Francisco, at \$1.50.....	178.20
Commissions, San Francisco, $2\frac{1}{2}$ per cent.	250.00
Freight from San Francisco to Swansea, at \$20 per 2240 lbs.	2,120 00
Insurance, 3 per cent.....	300.00
Expenses at Swansea:	
Sampling, \$1.50 per 2240 lbs.....	178.20
Attending sale and guarantee, 3 per cent	300.00
Harbor and town dues.....	26.70
Stamps, stationery, etc.....	10.00
	<hr/> 4,456.26
Net value	\$5,543.74

To smelt copper ore at the mine was, in these early days, simply out of the question. The first smelting works in California consisted of a small reverberatory furnace, erected under the direction of the writer at Antioch, in Contra Costa County, in the year 1863. The fuel was coal from the Mount Diablo mines, for which \$8 per ton was paid, and although lignite is not a very good fuel for reverberatory furnaces, with a step grate fairly good results were obtained, and no difficulty was experienced in producing a matte carrying from 45 to 48 per cent copper. Roasting was almost entirely dispensed with, as there was an abundant supply of low-grade oxidized ores to mix with the sulphides. These works were of a purely experimental capacity, not over ten tons per day, and although several thousand tons were smelted, the subsequent fall in the price of copper gave no encouragement to an increase in their capacity, and they finally ceased operations. At the Union copper mine, Copperopolis, a small blast furnace was erected under the direction of Constantine Heusch, and this produced considerable quantities of a very high-grade matte. At the Campo Seco mine, Calaveras County, several

thousand tons of ore were treated by kernel roasting, and with some success. A reverberatory furnace was erected on the Cosumnes River, and produced considerable matte of fairly good quality.

This period of activity practically closed in 1868 with a fall in the price of copper, increased cost of mining and lessened values as depth was attained, and the persistent failure of most properties to pay dividends. The report of J. Ross Browne for 1867 was made near the end of this productive era, and the statement there given of the shipments of copper ore and regulus (matte) is approximately complete for that decade. The following table is taken from that report:

Copper Exports from San Francisco, 1862-1867.

[Tons of 2376 pounds.]

YEAR.	TO NEW YORK.		TO BOSTON.		TO ENGLAND.		TOTAL.	
	Ores.	Regulus	Ores.	Regulus	Ores.	Regulus.	Ores.	Regulus.
1862.	86	.....	3,574 $\frac{1}{2}$ $\frac{6}{10}$	.....	.....	.....	3,660 $\frac{1}{2}$ $\frac{0}{10}$	.....
1863 ..	1,337	.....	4,208 $\frac{1}{2}$ $\frac{5}{10}$	.....	7 $\frac{1}{2}$ $\frac{5}{10}$	.....	5,553 $\frac{1}{2}$ $\frac{0}{10}$	.....
1864....	4,995 $\frac{1}{2}$ $\frac{6}{10}$	.....	5,064	.....	264 $\frac{2}{10}$	.....	10,234 $\frac{3}{10}$	.....
1865....	4,146 $\frac{3}{10}$	25	9,050	.....	2,591 $\frac{1}{2}$ $\frac{6}{10}$	.....	17,787 $\frac{1}{2}$ $\frac{8}{10}$	25
1866....	9,962 $\frac{8}{10}$	422	4,536 $\frac{1}{2}$ $\frac{3}{10}$	.....	12,384 $\frac{1}{2}$ $\frac{5}{10}$	80 $\frac{1}{2}$ $\frac{0}{10}$	26,883 $\frac{1}{2}$ $\frac{6}{10}$	502 $\frac{1}{2}$ $\frac{0}{10}$
1867....	2,633	178	.....	.....	1,878	141 $\frac{1}{2}$ $\frac{8}{10}$	4,511	319 $\frac{1}{2}$ $\frac{8}{10}$
Totals	23,070 $\frac{7}{10}$	625	26,434 $\frac{4}{10}$	.....	17,126 $\frac{1}{2}$ $\frac{3}{10}$	222 $\frac{8}{10}$	68,631 $\frac{4}{10}$	847 $\frac{8}{10}$

The report of J. Ross Browne on the Mineral Resources of the United States West of the Rocky Mountains for 1868 gives the following statement of the noteworthy smelting plants for the reduction of copper ores which had been erected in California:

LOCATION.	County.	Style of Furnace.	Estimated Cost.
Antioch	Contra Costa	Welsh	\$25,000
Copperopolis	Calaveras	German	75,000
Genesee Valley	Plumas	Local	30,000
James Ranch	Mariposa	Haskell's	20,000
Bear Valley	Mariposa	Haskell's	20,000
Hunter Valley	Mariposa	Haskell's	20,000
Near Placerville	Placer	Haskell's	10,000
Near Ashton	Colusa	Haskell's	6,000
Campo Seco	Calaveras	Welsh	30,000
Total .....	.....	.....	\$236,000

There were at the same time two in Oregon, one in Nevada, and one in Arizona. The following comment is made: "Several concentrating and roasting works have also been erected near some of the copper mines at considerable expense. The concentrating works at the Keystone mine at Copperopolis cost \$50,000. It is quite fair to calculate that \$500,000 has been expended in the construction of smelting and concentrating works on this Coast during the past four years, nearly all of which has proved a loss for the reasons stated."

There are wide discrepancies among the currently recorded estimates of copper production for this and the succeeding decade, and, in fact, for the entire time up to 1894, when the State Mining Bureau began the compilation of annual mineral statistics. It has been found impossible to present any record of California's total copper production worthy to be dignified as statistics, but such figures as are here presented serve to give a general comprehension of the productive course of the industry. Of such value only is the following statement of copper exports from San Francisco, compiled by a San Francisco paper in 1875:

	Tons.	Value.
1861	1,759	\$122,581
1862	3,389	293,194
1863	5,933	512,925
1864	14,315	1,994,660
1865	25,830	1,821,360
1866	19,813	1,383,852
1867	7,833	421,546
1868	5,077	227,925
1869	2,542	117,133
1870	2,254	113,732
1871	2,552	121,950
1872	2,193	115,970
1873	1,832	114,852
1874	1,352	67,400
Total	96,674	\$7,439,080

The above statement does not inform us what ton was used as a basis of calculation for a period when the short, long, and Welsh tons were variously so used, and it does not distinguish between copper ores and copper matte. It, however, corresponds in a general way with the annual condition of the industry. When transcontinental railroads were established

copper shipments began to be also made by rail, and the statistics of exports by sea became still less a reliable measure of production. From the beginning shipments by sea from San Francisco also included ores and some matte from adjoining States and Territories, including British Columbia, Oregon, Nevada, and Arizona, but the bulk of the shipments was from California mines. During the decades of the seventies and eighties the copper industry was practically at a standstill in this State, and the production of cement copper by the leaching of old dumps provided most of the output, the product in the main going East for the manufacture of mineral paint.

SHASTA COUNTY.

The history of the copper industry in Shasta County is part of the history of the base-ore belt now known as the copper belt; but that history for the period previous to 1895 is the history of attempts to mine the base surface ores for their precious metal values, and copper cuts but a very small incidental figure in the story.

The occurrence of rich copper ores in this mineral belt of Shasta County was noted early in the decade of the fifties, the discovery of copper being in fact practically contemporaneous with that of gold and silver, and copper ores were frequently noted through the succeeding years, but they caused no effort at their exploitation as such. Such ores were encountered in small quantities in tunnels which were opened in the search for gold and silver in the base-ore deposits of the middle and eastern parts of the belt, and a few tons, quite rich in copper and the precious metals, were shipped at different times to San Francisco, but no deposits were ever opened or regarded as valuable chiefly for their copper. For over a generation there was not only no recognition of copper as the element of main importance in this mining district, but there was no general recognition of the metal as one of the important mineral resources of the county. In 1893, but two years before the beginning of the career of the Mountain Copper Company, copper was not even mentioned in a review of the mineral resources of Shasta County in a local paper. The discovery that great bodies of sulphide copper ores lay buried below the gossan cappings of the belt followed the first thorough pros-

pecting of the Iron Mountain property, which begins the real history of the copper industry in this district. The past history of the belt itself is one of gold and silver mining and of nearly forty years of failure thereat, but the importance which copper has suddenly assumed makes this related history pertinent and of interest.

The surface placers of Shasta County were still rich, and its placer mining camps were prosperous when prospectors first noted both gold and copper in the vein formations of the belt.

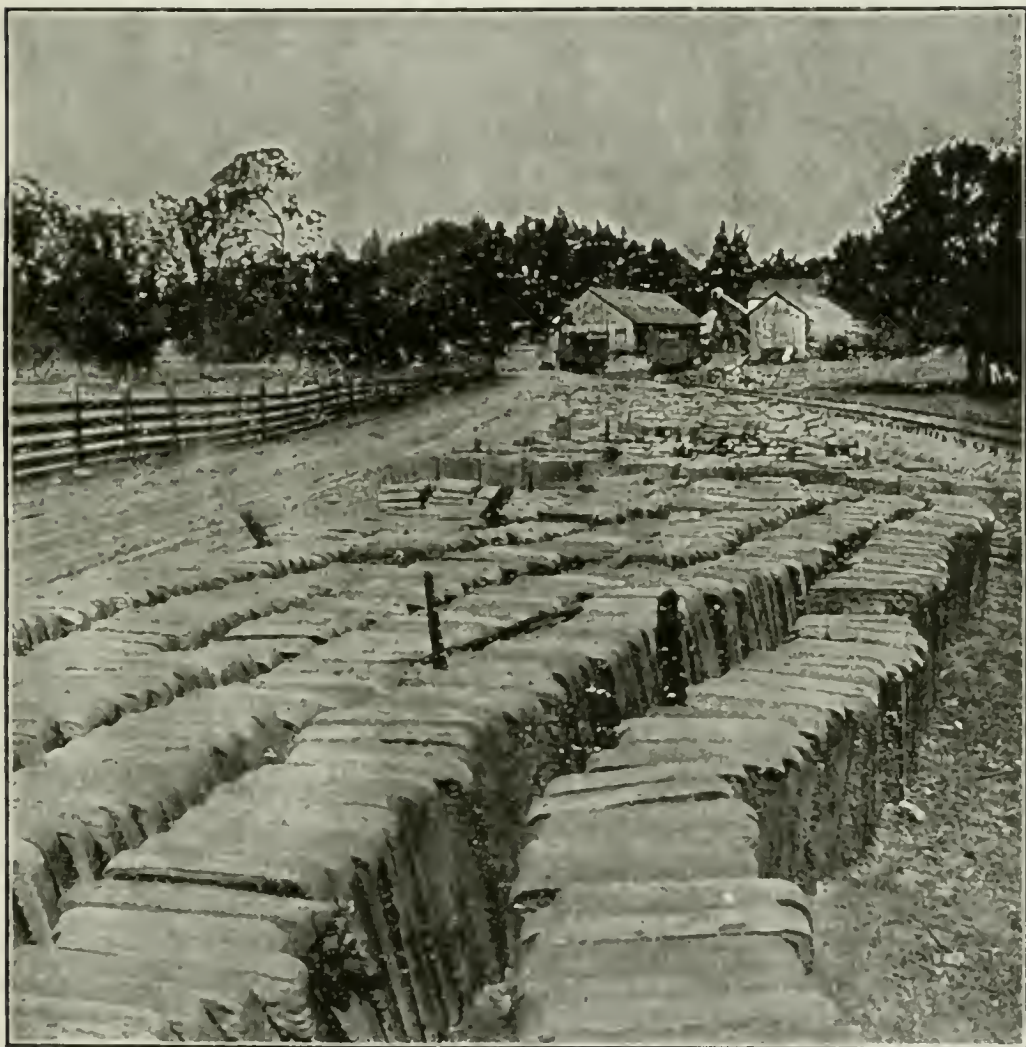


SURFACE MINING PLANT OF THE MOUNTAIN COPPER COMPANY, IN SLICK ROCK CAÑON, WITH IRON MOUNTAIN AT THE RIGHT.

Some of these placer districts closely flanked the copper belt, and had gained the gold in their gravels partly from the ores in the belt itself and partly from the gold quartz veins adjacent to the belt. There appear to have been no attempts at mining the ores of the belt until in the decade of the sixties. As early as 1853 placer gold was discovered in the region of Bully Hill, which became known as the Pittsburg district, by a man named Watson, with whom were associated Riggs, Hughes, and Silverthorn. With this discovery began a stampede which

resulted in the location of a large number of placer claims, most of which were of little value. Although some small placers are still worked in this district, active interest had lapsed long before 1870.

In 1862 gold was discovered in the surface rock of the Excelsior claim, near the present site of Copper City, by Jack



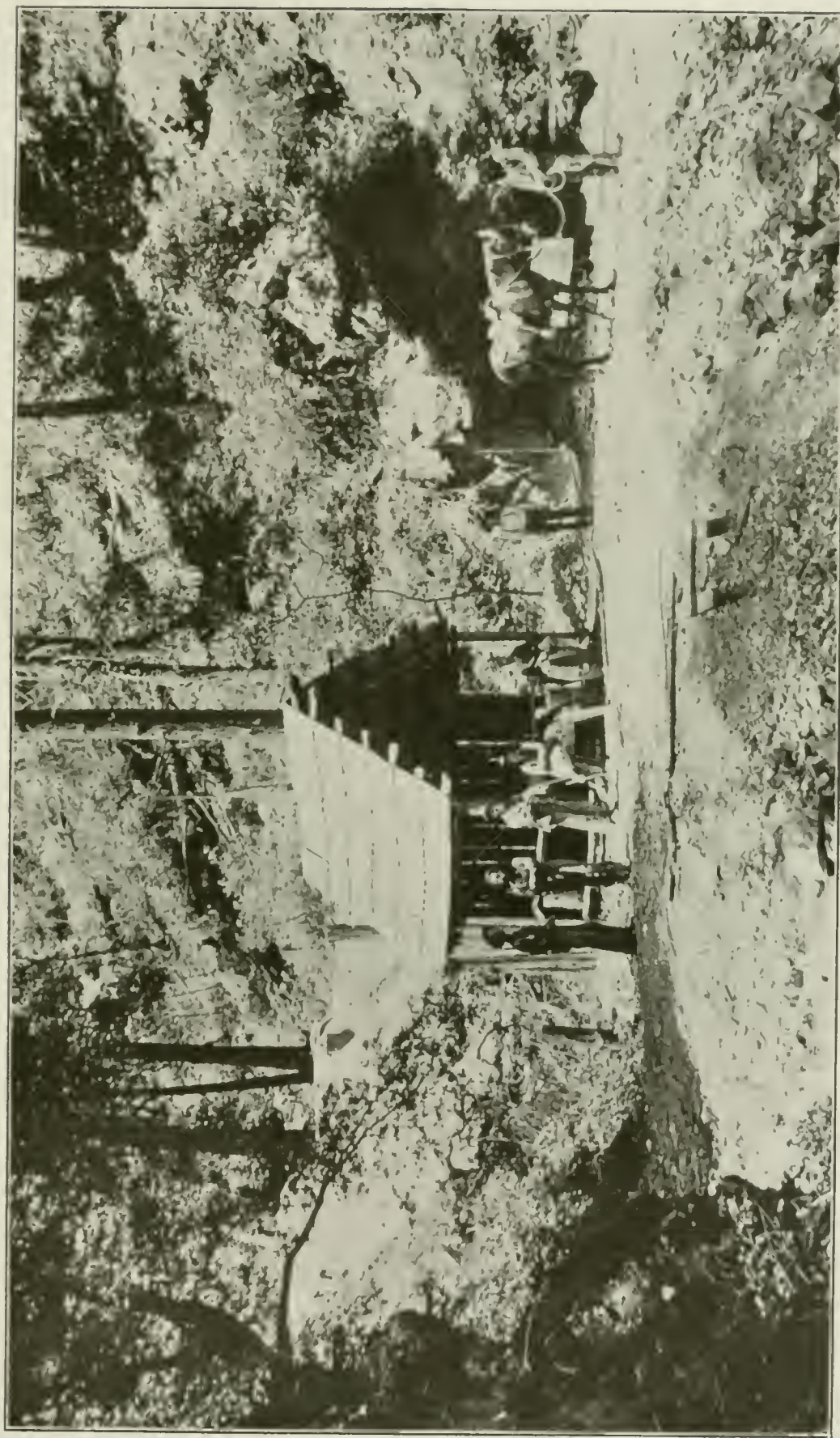
BLISTER COPPER FROM THE BULLY HILL SMELTER AWAITING SHIPMENT.

Killinger and J. P. Williams. The ore was found to contain silver as well as gold, and another rush into this district was begun for the location of the supposed rich veins of gold and silver. The hills were covered by locations for many miles. It was in the spring of 1862 that the ground now covered by the Bully Hill and adjoining claims was first located by Alexander Sanford, and the story of the Bully Hill mining

property was begun. The Killinger and Williams company, which was incorporated, sold stock and began the operation of their mine, which was continued until 1865. A shipment of ore was made to Swansea, and realized a fair profit; but as later shipments were less fortunate, they were not long continued. At the same time was organized the Baxter Mining Company, which operated on adjoining ground. Meanwhile, at Bully Hill, O. R. Johnson & Co. had acquired some of the claims located by Sanford and begun operations under the corporate name of the Bully Hill Gold, Silver, and Copper Mining Company. No attempt at reduction was made, but exploitation was begun on the east face of the hill at the site of what is still Tunnel No. 1 of the Bully Hill mine. The work was not successful, and the claims were eventually abandoned. In this period, in the early and middle sixties, Copper City, which was the result of the discoveries and the mining life of this district, enjoyed a lively boom and looked forward to a long and great career. These mining enterprises, dealing with very base surface ores at an early stage in the development of lode mining in the State, and at a long distance from ore markets, soon demonstrated the impossibility of realizing profits, the bottom dropped out of the mining boom and little was done for another decade.

It was early in the decade of the sixties that Iron Mountain began to cut any figure in the story. William Magee, a United States land surveyor, noted the enormous capping of gossan on the mountain, and in association with Charles Camden secured the property as an iron mine. It was idly held as a simple iron deposit of possible future value until 1879.

The decade of the seventies brought a revival of interest and activity to the Pittsburg district. The claims in Bully Hill, which had been abandoned by the Bully Hill Company, had been relocated by T. M. and J. W. Popejoy, who sold them to Alvin Potter & Co. in 1877. Potter reopened and retimbered the old tunnel (No. 1), and at the same time carried on other developments. Soon the property passed to the Extra Mining Company, which built the first mill at Copper City in 1877. A tramway was built at an enormous expense to convey ores from Bully Hill by gravity to the mill. During the few years (perhaps three or four) in which the company operated, it was said to have extracted as much as \$640,000 from these ores,



TUNNEL ENTRANCE AT THE SUGAR LOAF COPPER MINE, SHASTA COUNTY.

and interest on borrowed money, a part of the principal, and dividends were rapidly paid, but the property was finally turned over to creditors. The Extra Mining Company worked only the surface ores from these mines, having no successful process for the reduction of the baser ores, though an attempt was made at roasting. The mill was run for some years for the creditors, though not very successfully. Later Messrs. Potter and Hall obtained possession of the mill and tramway, purchased the Jenny June claim from H. C. McClure, and successfully worked these ores for a time, but the base ores finally caused them to abandon the work.

Iron Mountain makes its entry as a factor in the industrial story of the belt in 1879. In that year James Sallee, whose name was thenceforth to be prominently associated with the development of the copper belt, visited Shasta County and incidentally Iron Mountain. His assays of surface ores revealed the presence of silver and gold, and the outcome of his discovery was the acquirement of a one third interest in the property by himself and Alvin Potter, under whose direction the mine began the second period of its evolution.

This discovery was soon noised abroad and a characteristic stampede to the region ensued. The popular effect is well shown in a news letter to the Mining and Scientific Press from a Whiskeytown correspondent in June, 1880. He writes in part: "At this particular time, in this part of Shasta County, the silver boom is up high, and such expressions as 'the most extensive and the richest silver ledge the world has ever seen' are frequent. Some five or six miles from the ancient town of Shasta was known to exist what was called Iron Mountain. Nothing was expected of it and no one prospected there. A curious expert came from the city and has been secretly looking at its formations, assays have been made of his finds, and now the whole country is wild and claims are staked off for miles. A new silver belt has been discovered, the assays of which go away up into the hundreds."

Sallee found his gold and silver values in the gossan crusts of the surface, and this material constituted the ore that was subsequently worked. Under the direction of Sallee and Potter, ore was transported by pack train and wagon to Redding and from this point was shipped by rail to reduction works in Denver, Colorado. The ore was of sufficient value,

however, in spite of this laborious method of handling, to provide the means of constructing a wagon road from the mines to the railroad at Middle Creek, a distance of eight or more miles. With the completion of this wagon road the handling of the ores was to some extent simplified and the expense of its reduction was correspondingly lessened. The exact results of this method of work are not known, although it was kept up for some years, evidently with some profit.

In 1884, John O. Earl and Charles Ellsworth, representing a Honolulu company, bonded the property with the intent of buying it, and proceeded with the negotiations to the point of making a payment of \$30,000 and completing its equipment with an elaborate plant. The equipment of the mine included a 20-stamp mill, 125-horse-power engine, boilers, pans, and settlers, and in addition a small sawmill. Before any production was effected, however, the entire plant and mine were returned to the original owners for a consideration of \$10,000. James Sallee, as part owner and superintendent of the newly equipped mine, undertook its operation and worked it successfully until it was sold to the present owners, to whom it appeared as an immense deposit of valuable copper ore.

The first recognition of the possibilities of this mine as an available copper deposit was by Hugh McDonnell, who called it to the attention of Judge N. F. Cleary. The bond obtained by McDonnell was transferred to Cleary, who, through the influence of Alexander Hill of the Rio Tinto mine, was successful in effecting its sale to the Rothschild and Fielding people of London and New York. These factions combined in its purchase, paying for the property the sum of \$300,000, and establishing a working capital of \$200,000. This deal was consummated in the early part of 1895. The new company incorporated as the Mountain Mining Company and began at once the development of their deposits, the building of a railroad, and the erection of a suitable reduction plant. In September, 1895, a formal transfer of the Fielding interests was made to the Mountain Mining Company, Ltd., which continued its operations under the management of Mr. Hill. In January, 1897, the property was transferred to the present Mountain Copper Company of London, which has a capital of \$6,250,000.

The history of the Peck and Afterthought mines in the Cow

Creek district has been in many respects parallel to that of the Iron Mountain and the Bully Hill. The earliest attempts at operation were made for the extraction of gold and silver values from the oxidized surface ores. Later an effort was made to work the baser ores by a process of roasting and milling. C. M. Peck, who had erected the first ore mill in the vicinity of Copper City, also put up the first furnace for smelting in Shasta County. Having obtained for a nominal sum the property afterward incorporated and known as the Peck mine, and now included in the Afterthought mine, he began its successful operation upon the oxidized surface ores. In 1875, he erected a small reverberatory furnace, in which wood was to be used as a fuel in the reduction of the baser ores. Naturally this attempt was not successful, as these ores have since defied more rigorous methods. Upon the advice of a Mr. Williams, a second furnace, of the water-jacket pattern, was built, in which charcoal was to be used. The refractory character of the ore, which occasioned repeated freezing and other difficulties which could not then be surmounted, proved to be too much, and this attempt also ended in failure. It was claimed, however, that a continuous and fairly successful run of seven days was made at one time. The quantity of charcoal required amounted to nearly 1000 bushels per day. Subsequently, John Williams, father of the former superintendent, and afterward a man named Gerrish, made other unsuccessful attempts to reduce the ore in the same furnace.

Later on this property was acquired by Joseph Cone and others of Red Bluff, who erected the furnace that now stands on the property. This is a small water-jacket furnace of 25 tons capacity. Two attempts were made with this furnace, both of which terminated without success. During the period in which Peck operated in this district, he had discovered the Donkey mine, which he sold to A. J. Cook for the sum of \$1100. The ores of this mine are similar to those of the Afterthought.

SHASTA COUNTY.

Shasta County commands first and chief attention in a survey of the present condition of California's rising copper industry. In its great copper or "base ore" belt, which curves as a thirty-mile string of ore deposits through its west central part, are the two mines and smelting plants which yield most of the current copper output of the State, and the various extensive ore bodies whose exploitation gives the chief promise of an early and marked increase of copper production. While the copper industry is directly confined to one definite mineral belt, the county as a whole presents various features contributing to the exceptionally favorable conditions surrounding the industry.

The county lies in the mountainous region about the head of the Sacramento Valley, nearly equally distant from the western, northern, and eastern boundaries of the State, and is about 90 miles in length and 60 miles in width, having an area of 3675 square miles. The western border of the county is along the Trinity range summit, and the county reaches eastward high up the slope of the Sierra Nevada range, which bears westward and merges with the Coast Range in Shasta and Siskiyou counties. Short, irregular ranges fill the greater part of the county between the main ranges to the east and west. The Sacramento Valley thrusts its rapidly narrowing northern end a short distance up into the southwestern part, affording the principal agricultural and horticultural region of the county and meeting the long cañon of the Sacramento River a little above Redding, about 20 miles above the southern boundary.

In the southeastern corner of the county is Lassen Peak, an extinct volcano, the lavas from which have blanketed the eastern portion of the county nearly to the Sacramento River. From the valley and lower foothills of the southern part of the county the surface increases in ruggedness and elevation northward, as well as eastward and westward, until altitudes of 5000 to 6000 feet are reached. The copper belt occupies a position between these extremes, the altitudes of mountain

summits and cañon floors along the belt generally ranging between 1000 and 3600 feet.

Nature has given this county a splendid water-supply. The rainfall, occurring chiefly in the winter, exceeds forty inches as a rule, and the snows of the higher ranges maintain the streams throughout the summer months. The principal streams are the Sacramento, McCloud, and Pitt rivers, the first two rising in the mountains above the northern boundary, and the last in Modoc County. The Sacramento flows southward through the western half of the county in a deep, sinuous, and exceedingly picturesque cañon, crossing the copper belt a little above the apex of the Sacramento Valley plain. The torrential Pitt crosses the axis of the Sierra range through heavy forests and deep cañons to join the Sacramento in the midst of the copper belt. The no less picturesque McCloud discharges into the Pitt amid the gossan cappings of the copper deposits. Tributary creeks, prominently identified with the copper belt, also cross it on both sides of the Sacramento, and are valuable sources of water-supplies. There is thus a general convergence of the important rivers and creeks of the county in and through the chief mineral region.

The streams afford exceptionally valuable power resources. Their fall is rapid, their volume reliable, and the opportunities for the utilization of their waters for generating electric power are many. The Pitt presents many falls and cascades, and Fall River flows over a precipice sixty feet high just before joining the Pitt, high in the mountains. Important electric transmission plants are now in operation or in process of installation.

The county has almost inexhaustible supplies of timber in heavy forests of yellow and sugar pine and fir, clustered in the higher ranges about the upper courses of the chief rivers, those along the Pitt being especially available. Most of the timber and wood now used in large quantities by the principal mining companies is floated down from these sources. Elsewhere through the county, and adjacent to the mining districts generally, the timber supplies are scant or inferior, as a rule, though on the higher ridges, and on the more moist northern slopes of others, the yellow pine is here and there found in satisfactory abundance, and is extensively utilized. In the foothill zone the forest growths comprise mainly black, white,

and live oaks and "digger pine," and there are widespread growths of underbrush (chaparral), along with scrub oaks and small pines.

The California and Oregon line of the Southern Pacific railway system crosses the county and the copper belt along the course of the Sacramento River, and this important mining field thus has the advantage of close proximity to a main commercial highway. Several efforts have been made to accomplish the construction of a railroad westward from Redding through Trinity and Humboldt counties to Eureka on the Pacific coast, and this needed enterprise, so strongly invited by commercial and industrial conditions, will undoubtedly be carried out sooner or later, opening up a splendid mining region in the Coast Ranges, and providing Shasta County with a competitive transportation route by sea and rail.

While the copper belt, with which this bulletin is chiefly concerned, is now by far the leading feature of Shasta County's mineral resources, those resources are varied and quite widely distributed elsewhere. The eastern half of the county being generally buried under lava deposits which effectually hide the minerals that undoubtedly exist, the mining industry is confined to the western portion. The crescent-shaped copper belt presents its eastern end a little south of the center of the county, the belt, as indicated by exposures, being prolonged eastward into the lava sheet; but with this exception, the county's mining industry is confined to the western third of the county, and mainly to the portion west of the Sacramento River.

There were rich early placers in this region, and extensive recent and ancient auriferous gravel deposits remain, affording opportunities for various forms of placer mining, including gold dredging. Quartz mining was of slow development, owing to the base character of the ores in most of the districts in which gold-bearing veins were early discovered. Several quartz mining districts have been more or less successfully exploited, the most noted one being the French Gulch district at the western side of the county, in which the important Niagara and Gladstone mines, yielding free-milling ores, were developed many years ago. Other quartz mining districts are distributed along the western side of the county for sixty miles. The ores of these districts are free-milling in some places, but are usually base and they are variously characterized by the presence of

gold, gold and silver, and gold, silver and copper, in association with baser metals. To these districts mining enterprise is newly turning, giving promise of important new discoveries and developments.

The recent exploitation of the copper mines has placed Shasta far in the lead of the mineral-producing counties of the State. Its total mineral output in 1900 was \$5,574,026, nearly \$3,500,000 in excess of its nearest rival. Of this output, \$4,166,735 was in copper, the product of the Mountain Copper Mine. The gold and silver carried by the copper ores smelted and the silicious ores used as fluxes, together with the output of placer and quartz mines in districts outside the copper belt, afforded \$1,369,107 in the precious metals, of which \$733,467 was in gold and \$635,640 (coinage value) in silver. This makes Shasta also the leading silver-producing county of the State. In 1896, just before copper production began, the total mineral output was but \$813,593. While the mineral statistics for 1901 have not been compiled at this writing, it is estimated that the year's production will exceed \$7,000,000, further increasing Shasta's mineral preëminence. Various mineral products are minor features of the record.

The following table, giving the annual values of the chief three mineral products and the total annual mineral production from 1894 to 1900, inclusive, shows the expansion due to the recent development of the copper industry. Besides the value of gold, silver, and copper, the totals include the minor mineral products, embracing \$1500 in iron in 1894, chrome in 1895 and 1900, and mineral waters, lime, limestone, and brick in most of the years. The gold increase is small, owing to the closing of several important gold mines at about the period that the Mountain Copper Company began producing gold as a by-product. The large increase in silver in 1900 is partly due to its being measured in coinage value for that year instead of in commercial value as in preceding years:

	Gold.	Silver.	Copper.	All Minerals.
1894	\$617,436	\$5,032	.....	\$715,769
1895	781,696	28,417	.....	811,233
1896	599,209	24,233	\$184,208	813,593
1897	569,071	96,869	1,535,966	2,224,700
1898	860,180	171,868	2,465,830	3,510,728
1899	873,719	196,213	3,565,023	4,661,980
1900	733,467	635,640	4,166,735	5,574,026
	<u>\$5,034,778</u>	<u>\$1,158,272</u>	<u>\$11,917,762</u>	<u>\$17,464,809</u>

As these figures indicate, copper is the chief product and the chief basis of the mining prosperity and prospects of the county. All of the silver is produced by the smelters from ores mined chiefly for their copper; and in the temporary absence of production in some important mines, the gold output has, until recently, been sustained in the same way.

At the present time several prominent independent gold-producers are being operated, and the output, exclusive of gold produced by ores mined chiefly for copper, is as great as it has been at any time during the past ten or fifteen years.

THE COPPER BELT.

Shasta County's copper belt is composed of a series of ore deposits arranged in the form of a crescent, which bends through the low mountains and foothills directly north of the head of the Sacramento Valley, and which spans a distance of about twenty-five miles between the eastern and western horns. The apex of the Sacramento Valley plain and the city of Redding are near its western end and but a little south of the chord of the arc described by the belt. Iron Mountain, at the end of the western horn, is about ten miles northwest of Redding, in a direct line, and the eastern horn, in the Furnaceville district, is about twenty miles north of east from the same point. The length of the belt is approximately thirty miles, and the width from one-half to four miles.

The term "belt" is used with the broad meaning which it properly carries, and not as synonymous with "lode." The ore deposits do not mark a practically continuous fissure system in which directly related vein formations have resulted, but occur as disconnected masses, or groups of vein formations, forming individual lodes and districts. These groups of deposits vary in form of occurrence from massive, flat-lying, lenticular beds of sulphides on the west, to irregular vein formations in the eastern half of the belt, and they also vary in their mineralization; but they are successively ranged, with considerable regularity, along the curved line described, forming a belt three or four miles wide in places. In several ways this series of deposits presents features of unity and individuality, which enforce its conception as one definite mineral belt, and

which set it apart from other ore deposits in that part of the State.

The belt is throughout superficially marked by massive exposures of the gossan which nearly everywhere caps its mineralized formations. Upon the elevations between the cañons cut by the streams, these dark croppings of the iron oxides resulting from the decomposition of surface sulphide ores stand out in places with striking boldness. A cursory survey of the belt as a whole shows these ferruginous surface formations to be practically continuous throughout, but in an irregular and disjointed way, and coursing in varying directions. Especially striking is the great gossan cap of Iron Mountain, with which the belt worthily begins, or ends. The ridge forming this mountain rises nearly a thousand feet above Slick Rock and Boulder creeks on either side, over a mile apart, and at the top the gossan formation, 300 feet wide, displays nearly perpendicular walls that rise high above the top of the slope into which the tunnels of the Mountain Copper Company open. Southerly from Iron Mountain but two or three known copper deposits, widely separated, occur, the mineral formations of the belt being succeeded through the adjacent regions by gold quartz veins.

For ten miles northeasterly from Iron Mountain and nearly to the Sacramento River, the belt is outlined by a quite continuous succession of both gossan outcrops and important groups of copper claims, in many of which exploration is steadily proceeding. For the distance named, the belt, as indicated by the distribution of copper mining claims, exhibits a width of approximately three miles. Between Boulder Creek, at the northern side of Iron Mountain, and the Sacramento River, the belt is cut through by three deep creek cañons.

The belt intersects the Sacramento River at about the point where it receives the Pitt, and for nearly ten miles eastward it exhibits its gossan croppings on both sides of the latter stream, but mainly on the northern side. About four miles east of the Sacramento the Pitt is joined by the McCloud River, which thus ends in the midst of the copper belt. Farther eastward the belt is entered by the Pitt where it turns on its final westward course, and it is crossed by streams tributary to the Pitt and Sacramento. Through the whole course of the belt a

multitude of gulches help give a very rugged character to the region. These gashes made by the waters in the "iron hat" of the belt further diminish its apparent continuity, the gossans having here and there been eroded away or covered by surface wash, and being found principally on the elevations.

The geology and mineralogy of the belt are specially treated of in the succeeding section. The ore deposits are composed mainly of sulphides occurring in eruptive formations. West of the Sacramento the deposits are in the form of irregular lenses in flat or inclined positions. They have been shown, in some cases, to be several hundred feet in length and breadth, with thicknesses of 50 to 300 feet, displaying contents amounting in the Iron Mountain and Balaklala mines to quantities exceeding a million tons, and indicating similarly large proportions in other properties of smaller development. In the central and eastern portions of the belt the ores occur in vein formations.

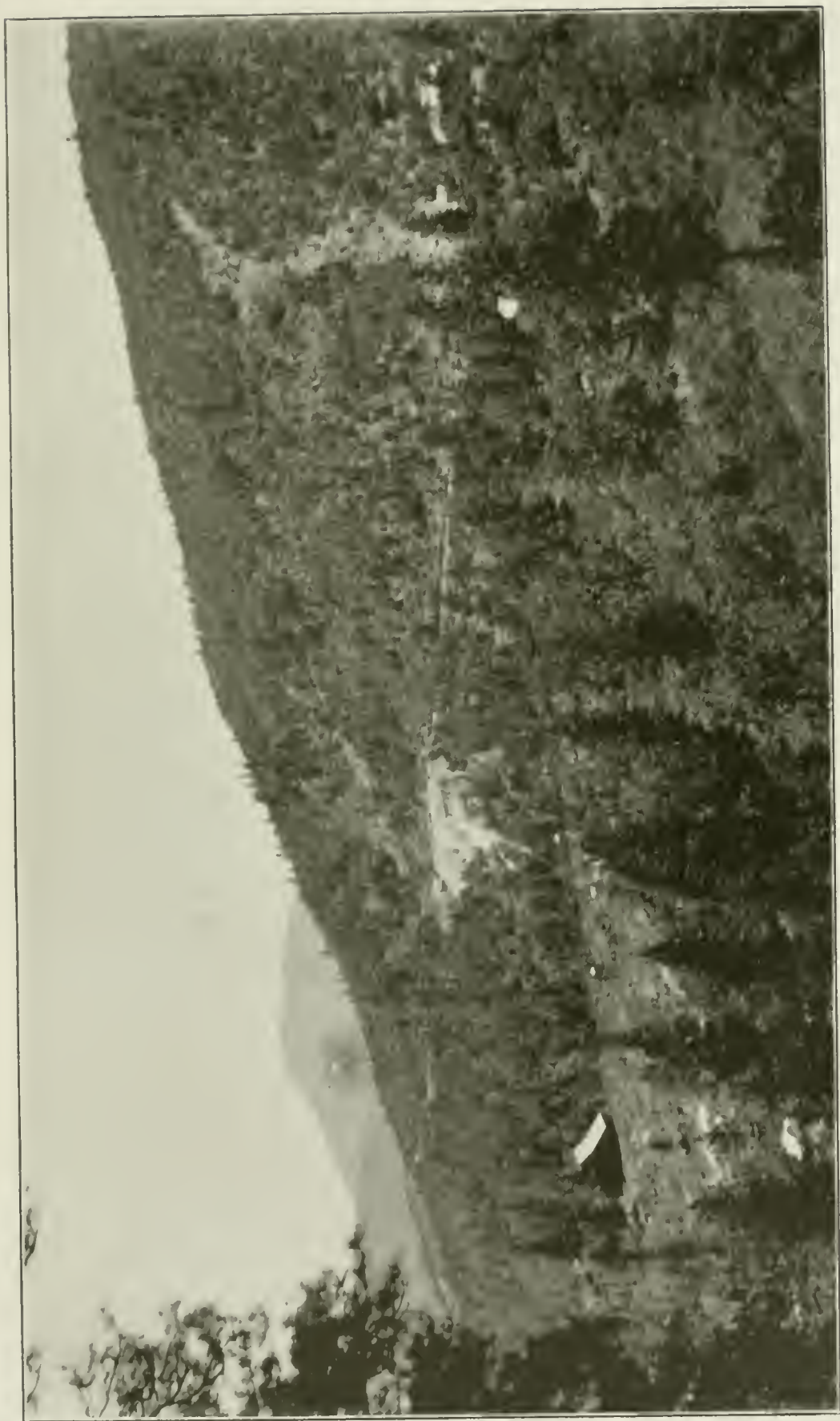
The ores all carry gold and silver. West of the Sacramento River the percentages of the precious metals are small, though constituting an important element of the ore values. The Iron Mountain ores are stated to yield about \$1 in gold and two ounces of silver per ton, and these quantities are probably characteristic of the ores of the other deposits of that part of the belt. These ores carry very low percentages of the baser metals, as zinc, antimony, arsenic, etc. In the central and eastern districts of the belt the gold and silver, as well as the copper values, are frequently much higher than in any large ore bodies developed to the west, and they carry the baser elements in much greater quantity and variety. Throughout the belt, the most important copper properties have in past years been worked for the gold and silver values remaining in the decomposed portions of the deposits near the surface and above the copper sulphides to which attention is now directed.

Adjacent to different parts of the belt are gold quartz districts, in which are many veins carrying low, medium, or high grade ores, which are base, as a rule, and can not be efficiently and profitably reduced by milling processes. The western horn of the belt is practically surrounded by such veins. They occur notably in the region of the old town of Shasta, four miles south of Iron Mountain, and are distributed for several miles south and east of this end of the belt through the Shasta and Flat Creek districts, the latter lying between the belt and

the Sacramento River. Eastward from this portion of the belt, across the Sacramento River and within and without the chord of the belt's arc, is the Old Diggings district, presenting groups of quartz claims extending over several miles. Some important quartz mines have been developed in these districts, including the Mount Shasta in the Shasta district, and the Texas Consolidated in the latter. Other quartz districts similarly attend the belt at other points along its course, and gold quartz veins are abundant in close proximity to the belt generally. These silicious ores thus provide abundant and convenient fluxing materials for use in smelting the sulphide copper ores. In turn, the smelters have created a market for these ores and enabled the development and mining of a number of quartz properties. The stimulus thus afforded quartz mining in this region is one of the important local benefits of the development of the copper industry. Gold ores are not only supplied from closely adjacent districts, but are hauled by teams and shipped by rail from quite remote localities, including points in Siskiyou and Trinity counties, the ores being rich enough to stand the large transportation costs.

Other fluxing materials are equally plentiful and convenient. Iron ores and limestone are also used for fluxing. Limestones are the most abundant, and are found along large belts near the smelters. The supply is practically inexhaustible. Iron ores, both magnetite and limonite, have been used for some of the more refractory sulphides, but the former has not been found to be suitable for such uses. It is now believed that a mixture of ores from this belt can be made that will obviate the use of iron ores.

The copper belt thus presents many favorable conditions for copper mining and smelting. There are distributed through a long mineral belt massive ore deposits whose quantities, as well as values, are attractive to conservative mining capital. These deposits are usually embedded in great hills, and can be economically explored and mined through tunnels. Water is especially abundant, and desirable sites for reduction works are conveniently available. Opportunities for the generation of electric power are widely present. The belt is bisected by a main railroad line, and highways reach the various districts. Climatic conditions are all favorable. The wood and timber supply is ample. At the Keswick smelters wood now costs

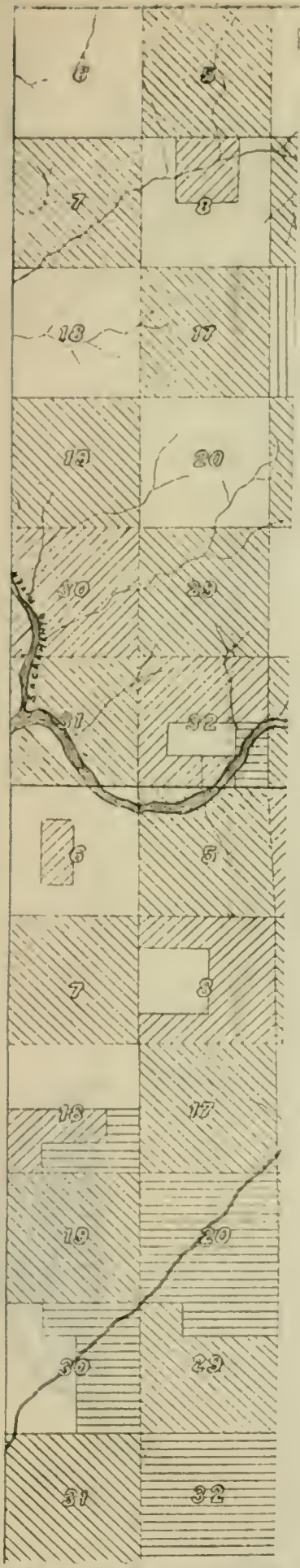


VIEW OF BULLY HILL, COPPER MINES FROM THE NORTH

about \$4.25 per cord. Alabama coke, carrying 16 per cent ash, can be delivered at Redding for about \$13 per ton. Belgian coke, with 15 per cent ash, has been obtained for \$12.20 per ton.

In a survey of the present status of the industry along the belt, the attention is chiefly claimed by the producing localities of Iron Mountain at the extreme western end, and Bully Hill east of the middle of the belt. From the Iron Mountain mine the Mountain Copper Company has extracted, since 1896, about 825,000 tons of ore, which has been carried by a narrow-gauge railway eleven miles down the cañon of Slick Rock Creek to the company's smelting plant at Keswick, one mile west of the Sacramento River. The matte and blister copper here produced and shipped to the company's refinery in New Jersey have produced about 120,000,000 pounds of fine copper to January 1, 1902. Dividends to December 31, 1900, amounted to considerably over 50 per cent of the capital stock of \$6,250,000. With very large ore reserves, with a recently enlarged and improved smelting plant of about 1000 tons daily capacity, with a total force of about 1200 men, and with annual local expenditures of about \$2,000,000, the Mountain Copper Company is a large factor in sustaining local industrial prosperity, and has a considerable future period of profitable operations on a large scale insured.

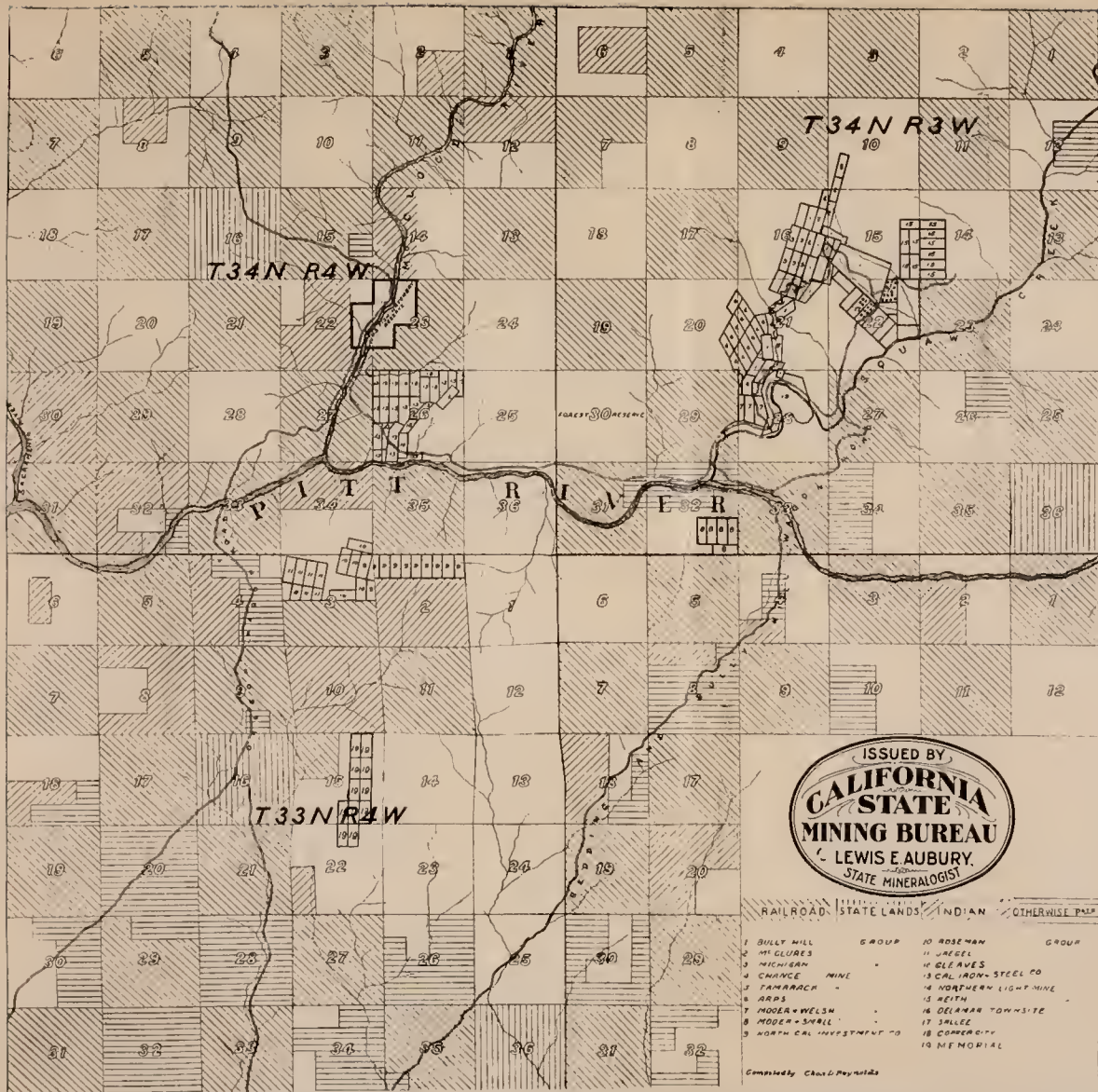
Near the middle of the belt is the Bully Hill mine and smelting plant, which have within a year assumed great prominence as a rich and promising mining property. Next to the Mountain Copper, the Bully Hill is by far the most extensively explored and developed mine of the belt, the tunnels and drifts in the Bully Hill mine proper aggregating over two miles in length. Several other groups of adjoining claims help make up the extensive holdings of the Bully Hill Copper Mining and Smelting Company. Favorably situated near the mine is the splendid modern reduction plant, which has a present capacity of 150 tons of ore per day. During the ten months of operation succeeding the beginning of production in May, 1900, the smelter is credited with reducing 50,000 tons of ore averaging 10 per cent copper, affording 5000 tons or 11,200,000 pounds of copper, with an equal value in the precious metals. This is an unofficial estimate, but is believed



MAP OF A PORTION
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IN THE SACRAMENTO RIVER INCLUDING
ALL MINING PROPERTIES



MAP OF A PORTION OF THE SHASTA COUNTY COPPER BELT EAST OF THE SACRAMENTO RIVER, INCLUDING THE BULLY HILL DISTRICT, SHOWING THE PRINCIPAL MINING PROPERTIES.





MAP OF A PORTION OF THE CHASTA COUNTY COPPER BELT EAST
THE BULL HILL DISTRICT SHOWING THE FRENCH





SULPHIDE COPPER DISTRICT

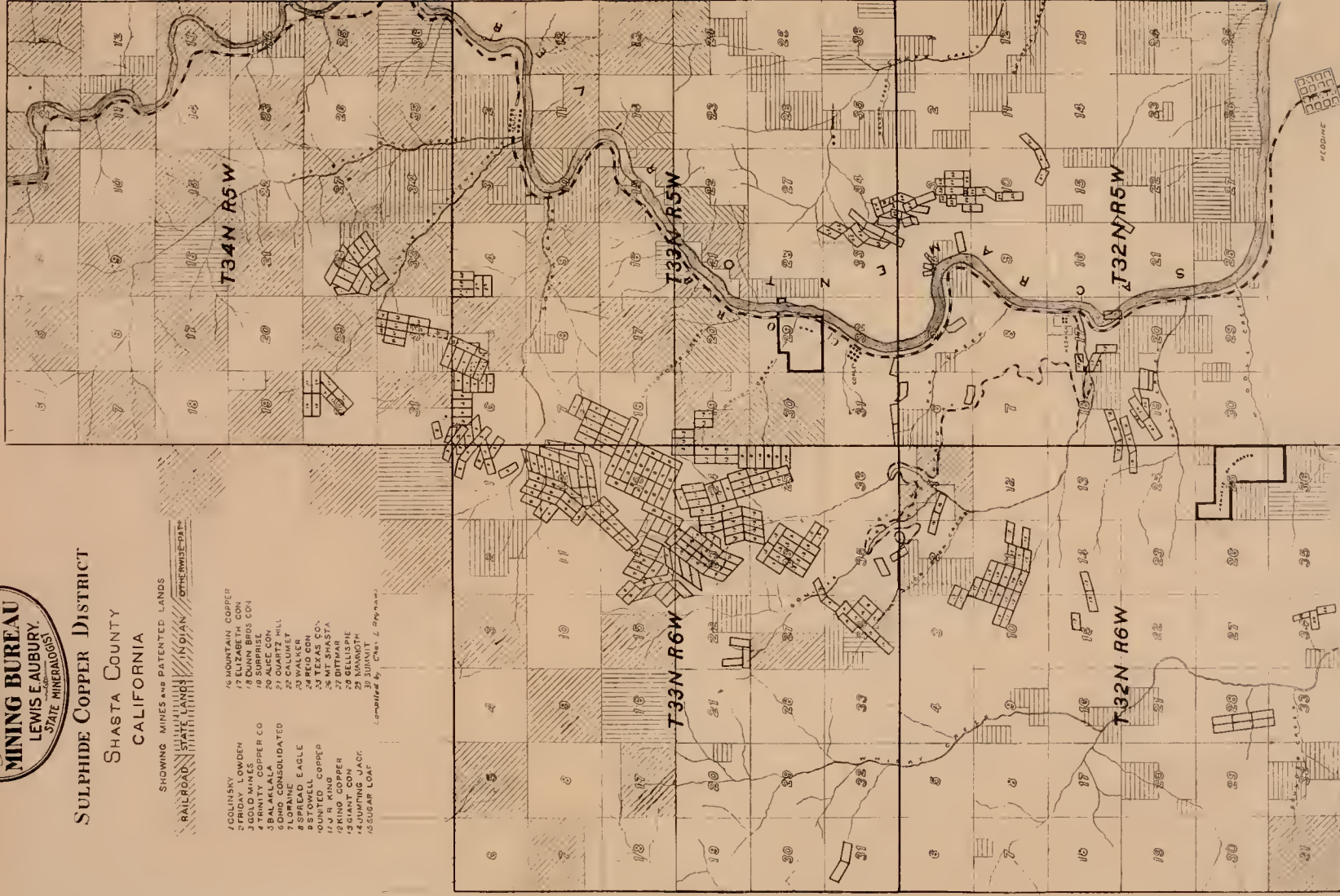
SHASTA COUNTY
CALIFORNIA

SHOWING MINES AND PATENTED LANDS
RAILROAD STATE LANDS 15 DIAN OTHER WIDE PAT.

1 COLINSKY
2 FRIDAY LOWDEN
3 GOLD MINES
4 TRINITY COPPER CO
5 BURNING CO
6 DING CONSOLIDATED
7 LORANE
8 SPREAD EAGLE
9 MOUNTED COPPER
10 J. B. KING
11 KING COPPER
12 BURNING CO
13 LUMING LAG
14 SUGAR LOAF

16 MOUNTAIN COPPER
17 ELIZABETH CON
18 DUNN BRDS CON
19 BURNING CO
20 ALICE CON
21 QUARTZ HILL
22 CALUMET
23 CALUMET
24 CALUMET
25 TEXAS CON
26 MT SHASTA
27 DITMAR
28 BURNING CO
29 MAMMOTH
30 BURNIT

Compiled by Geo. L. Reynolds



MAP OF THE SHASTA COUNTY COPPER BELT WEST OF THE SACRAMENTO RIVER, SHOWING THE PRINCIPAL MINING PROPERTIES.

to be approximately correct. The output will probably double within a year.

The success and promise of the Bully Hill mine have been a strong additional stimulus to the exploitation of other deposits of the belt, to which attention was first directed by the striking success of the Mountain Copper Company. As a result of the encouragement thus given to local holders of important prospects, and of the interest thus awakened in Eastern and foreign promoters and investors, a number of groups of claims are steadily undergoing exploration by the owners or by the



BULLY HILL, SHASTA COUNTY, SHOWING ORIGINAL TUNNEL OPENED IN 1863.

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Prospecting activity is especially noticeable along the western portion of the belt, where in size, position, and nature the ore deposits so much resemble those of Iron Mountain. As before observed, groups of claims are closely ranged for ten miles northeast from Iron Mountain, embracing broken and wooded cañons, hillsides and elevations, and covering widths of three miles in places. They vary greatly in the extent to which explorations under the massive gossan croppings have extended. From the Sacramento River eastward for about eight miles, to the neighborhood of Bully Hill, there is a succession of mining claims yet but little explored. From the Bully Hill district on to the Afterthought and Donkey mines at the eastern terminus of the belt there is a similar gap of several miles displaying no prospects of much present importance.

The Balaklala, Mammoth, and Shasta King mines on the western side of the river, and the McClure adjoining the Bully Hill, are the developing properties in which interest is now mainly centered and which seem to warrant the anticipation of Shasta County that they will become producing mines in the not distant future.

The Balaklala comprises about 60 claims, and 3000 feet of tunnels and as many feet of diamond drill holes have developed low-grade ore bodies estimated to contain over 2,000,000 tons. The latest developments indicate that this quantity is to be greatly exceeded in the property and that possibly this will prove the greatest deposit of the belt. It is being further explored under bond by a company of Chicago and Pittsburg capitalists, who are understood to contemplate production on a large scale.

For about two years public interest in the future has been centered on the operations of the Trinity Copper Company, headed by Thomas W. Lawson, of Boston. Its chief property is the Shasta King, about four miles east of Iron Mountain, in which there has been opened up a body of low-grade ore reported to exceed 1,200,000 tons. Development is actively proceeding under the management of Austin H. Brown. The company has secured a smelter site a half mile from Kennet, to which a spur railroad is being built. The reported intention is to proceed with the erection of a smelter of 500 tons or more capacity and to build a railroad from the mine to the smelter.

The company also owns the King Copper in this portion of the belt.

The Mammoth, comprising nearly 1000 acres of land on the belt, likewise displays a large body of low-grade ore, and it is being extensively developed by Eastern capital, with production rather than promotion as the object in contemplation.

The Mount Shasta Gold Mines Corporation, composed mainly of Chicago capitalists, which owns the Mount Shasta gold mine in this county, entered the copper field in 1901 and has secured some copper properties, the most important being the McClure group on Bully Hill. The veins of the Bully Hill mine enter this property, and developments are reported to make a very valuable showing of ore similar to that of the adjoining producer. The company has bought the townsite of Sallee for a smelter site and has announced its intention of erecting a reducing plant and beginning producing operations. These plans, or any of them, if carried out, will largely increase the copper and precious metal output of the belt. Companies, syndicates, and individuals are exploiting other properties, usually composed of quite a number of mining claims.

The State Mining Bureau's register of the mines of Shasta County lists fifty-seven copper properties belonging to the copper belt. A summary of some of the data relating to them may help give a general idea of the conditions and the present state of development. Tunnels have been opened or started in forty-five of these properties. Aside from the thousands of feet of tunnels and stopes in the Iron Mountain mine, the total length of tunnels run is about 32,200 feet and that of the drifts is 7600 feet, giving a total of 39,800 feet. Eight properties have tunnels aggregating 1000 feet or more each. The Bully Hill is credited with 8000 feet of tunnels and 5500 feet of drifts, or 13,500 feet of mine openings. The adjoining Baxter and Winthrop group, belonging to the Bully Hill Company, has 3000 feet of tunnels and 1000 feet of drifts, giving the Bully Hill Company 17,500 feet of exploration and development work accomplished at practically one point. Six other properties have tunnels as follows: Afterthought, 1000 feet; Balaklala, 3000 feet; Black Diamond, 1500 feet; Michigan, 1575 feet; Northern Light, 1200 feet; Shasta King, 2400 feet. No other properties have 1000 feet of openings.

Shafts cut a noticeably small figure along the copper belt,

and they may be practically regarded as non-existent. They have nearly all been early prospect shafts sunk in preliminary surface exploration. Throughout the belt development and mining are conducted through tunnels, which the topography so generally favors. Twenty-one properties have been opened by shafts, but only seven are 100 or more feet deep, and the deepest, that of the Afterthought, is 300 feet. The record of development work includes but six open cuts, aggregating 400 feet. The openings here noted have been supplemented in the work of exploration along the belt by thousands of feet of diamond-drill borings, chiefly made by the Mountain Copper Company in its own and in bonded properties.

Tunnels and drifts have reached depths of more than 250 feet below gossan outcrop in eleven properties, and more than 500 feet in four. The deepest point reached has been in the Bully Hill, 700 feet below the top of the gossan on the hill. The Afterthought has reached 635 feet in similar depth, the Iron Mountain 600 feet, and the Sugar Loaf 670 feet, the last having 700 feet of tunnel openings. The copper belt has thus not reached the stage of "deep mining." The deepest ores yet displayed are above the floors of the creeks and gulches about them. What lies at greater depths in the veins of the central and eastern parts of the belt must be reserved for future reports.

The range of the altitudes credited to the mines is wide, and illustrates the rugged nature of the country. The highest properties are in the elevations west of the Sacramento River. The top of Iron Mountain is 3000 feet above the sea and 2400 feet above the Sacramento River. The Marshall and Waters group, two miles north of Iron Mountain, includes a point 3500 feet in altitude, and the Summit group, farther north, lies at 3000 feet. The lowest property is the Hotchkiss, 750 feet, a little south of Bully Hill, which rises to 1400 feet. Forty-four properties are above 1000 feet, twenty above 2000 feet, and fourteen are at altitudes below 1000 feet. Redding, on the Sacramento River, is 550 feet above the sea.

The latest record showed 1800 men directly employed in mining, smelting, and exploration at thirty-four properties along the belt. The Iron Mountain mine and smelter gave work to 1200 men, and 350 were employed by the Bully Hill Company. The remaining 250 were engaged mainly in

exploration work. The Balaklala mine employed 60 men, two mines employed 20 each, and ten 5 or more each, driving tunnels requiring but a small force.

The development of water powers and electrical plants, the building of towns and branch railroads, the stimulation of gold mining, lumbering, manufacturing, and other industrial enterprises, and increase of population and of general prosperity are among the features incidental to the progress of the copper industry and mainly consequent on it. A branch railroad along the Pitt River from near Kennet to the neighborhood of Bully Hill and probably on into the timber region promises early realization. The smelting town of Keswick has a population of 1800. Kennet, on the Sacramento River, is a small town that expects to grow and prosper with promised developments. The small ancient town of Copper City, near Bully Hill, with a population of about 100, anticipates another revival. In and about the new town of Delamar at Bully Hill there is now a population of about 1500. Redding, the county seat and the distributing point for a large region of Northern California, has a population of over 4000 and is experiencing marked growth and prosperity.

GEOLOGY OF THE COPPER BELT.

It would not be possible to include in this report a discussion of the geological features of the copper belt that would be in any degree complete. Only brief statements can here be given regarding the various classes of rocks more directly connected with the ore deposits.

The oldest sedimentary rocks that are encountered here are those of the Devonian age. They are found especially along the western districts, extending at intervals northward from Clear Creek to the Big Backbone, or beyond. They have been found also to the east of the Sacramento River, in the vicinity of Baird and perhaps farther south. These rocks are mainly metamorphic, often becoming schistose or crystalline. They include the limestones and their underlying slates, or schists, near Kennet and Copley, and at the lime quarry on Clear Creek in the vicinity of Horsetown. Probably the schists entangled with the eruptives throughout the western districts are of Devonian age.

The next succeeding period represented among the sedimentary rocks is that of the Carboniferous. This period is represented by the conspicuous limestone belt east of the McCloud River, near Baird, and extending in a southerly direction toward the Great Valley to the south of Pitt River. Bass's ranch, on the old Oregon road, is a classical locality for Carboniferous fossils in California. The Carboniferous beds, like the Devonian, include both limestones and slates, both of which are in a large degree metamorphic. The thick limestones are underlain by dark slates, and both are very fossiliferous. These beds will be referred to again in connection with certain metalliferous deposits in the vicinity of Pitt River.

Succeeding the Carboniferous period, the next oldest sedimentary rocks in this region are those of the Triassic age. These occur still farther east in the vicinity of Squaw Creek and Bear Mountain. They consist for the most part of dark, thin-bedded, silicious slates, overlain in some places by limestone, which is usually very fossiliferous. The Triassic strata are much less affected by metamorphism than either the Carboniferous or Devonian rocks. The limestone is highly crystalline, but the slates are rarely if ever schisted, though they are much disturbed in their position, being usually more or less tilted.

The lower portion of the Triassic beds contains thick beds of fragmental volcanic rock of an andesitic character, resembling beds of volcanic tuff of a much younger age. These are especially noticeable near the bridge on Pitt River east of Copper City. It is curious to note the general resemblance of the sediments in these three distinct periods. In each case the lower beds are of a slaty nature, while the upper are of limestone. The limestones to the north and east of Bully Hill belong to the Triassic period, and have furnished not only an abundance of marine shells, but also the bones of extinct saurians.

The last important sedimentary beds that require mention are those of the Cretaceous period. These beds are confined to the lower foothills of the copper belt, and to the valley floor. They occur near Horsetown, Redding, Sand Flat, Dry Creek, and Cow Creek, forming an irregular belt or zone extending in a northeasterly direction toward the low country north of Lassen Peak. They are of Upper Cretaceous age, and are

generally fossiliferous. The beds are of shale and sandstone, which have a relatively slight dip to the south or east. It is this series which has been prospected for petroleum during the last year.

The Cretaceous beds, and in fact some of the older beds of the foothills, are overlain by beds of volcanic tuff which were once more extensive in their distribution than now, and also by accumulations of alluvial gravels. It is impossible in the limited space of this report to give more than a mere outline of these deposits, but it is important that at least a few paragraphs be selected from the geological history of the region in order that there may be a better comprehension of the paragraphs which follow.

THE IGNEOUS ROCKS.

More vitally connected with the ore deposits of the copper belt are the igneous rocks embraced in its area. Those which are directly concerned are either of one class, or they belong to classes closely related and are probably of about the same age. The geological age to which they seem referable can not be younger than the Cretaceous nor older than the Triassic. Their approach toward the surface of the earth as intrusions covering an extensive territory was no doubt very gradual, though in its late stages it was doubtless accompanied by eruptions of lavas and the formations of dikes that were of more sudden creation. Most of these rocks are of an acid character, or in other words, high in their percentage of silica. It would be interesting to note the relation of these igneous rocks to the topographic features of the country, to the older sedimentary rocks, and to the ore deposits themselves, but this would carry the discussion beyond the limits of the present paper. A little may be said, however, regarding the structural features of the country and the classification of these rocks.

In the main, eruptive or igneous rocks have the appearance of underlying all of the sedimentary rocks, including those of Devonian as well as those of Cretaceous age. In all the larger streams, and in many of the smaller ones, erosion has cut down through the overlying sedimentary rocks and exposed the eruptives along the valley bottoms. As extensive intrusions

which have risen into the old sedimentary rocks, there are many variations, and no less variety also in the flows of volcanic rocks that finally resulted. The deep-seated phases of these eruptions include granite, granite porphyry (quartz porphyry), and diorite, including quartz diorite. These rocks are either coarsely or finely crystalline, and of a light gray color, greenish or dark, varying with locality.

Rhyolite, trachyte, and andesite are names properly given to surface flows of volcanic rocks, and such flows occur throughout the copper districts, associated with tuffs and breccias of a similar age and character. These flows doubtless correspond in character to the deep-seated rocks already mentioned, and represent the outpourings that followed their action. These volcanic rocks, including both the flows and the fragmental rocks, are especially seen near Iron Mountain, the Shasta King mine, Bully Hill, and the Afterthought. The term porphyry should perhaps be applied only to dike rocks, and some of these are found along the copper belt. There are certain dikes, however, which cut the limestones in the vicinity of Baird, which should be classed as diabases. These accompany the iron ores and the occurrences of magnetic pyrite.

METAMORPHIC ROCKS.

A third and important class of rocks that are frequent in the copper belt includes most of the crystalline limestone, and certain "slates" and schists near Copley, Redding, and Clear Creek. These rocks are largely of Devonian age, and appear to be partly of an igneous origin. Truly metamorphosed sedimentary rocks are very often involved in the eruptive and volcanic rocks along the copper belt, and are not always easily distinguished from them, where the metamorphic action has been intense and the weathering considerable.

In the main structural features, therefore, the copper belt consists of a number of north and south folds, or belts, of sedimentary rocks, which belong to a succession of periods, and beneath which extend the rocks of the great granitic intrusion. Dike rocks have been found penetrating both the eruptives and the overlying sedimentary rocks. A clear knowledge of these structural features in a measure simplifies many things relating to the ore deposits.



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GEOLOGICAL MAP OF THE WESTERN PORTION OF THE SHASTA COUNTY COPPER BELT.

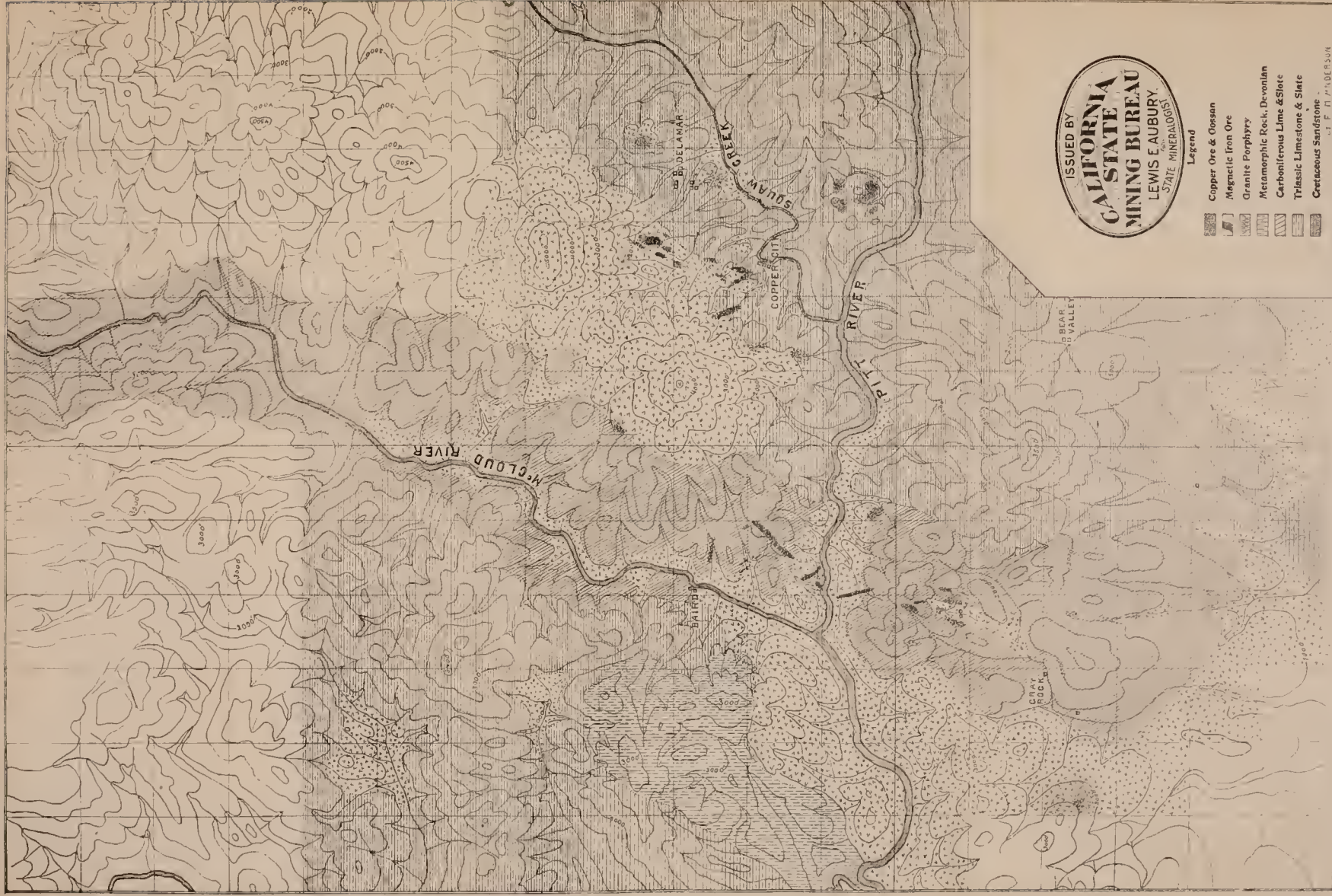
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GEOLOGICAL MAP OF THE EAST-CENTRAL PORTION OF THE SHASTA COUNTY COPPER BELT.

ORE DEPOSITS.

The deposits of copper ore belonging to the copper belt, that are now attracting so much attention in this county, are quite unlike the usual quartz veins as ordinarily understood, both as to their forms as ore bodies and as to their origin, though probably they are not different from bodies of copper ore occurring elsewhere. There is considerable misconception in this regard. As a rule these ore bodies are of very great size and consist of large bodies of massive sulphides occurring along the borders of or within areas of eruptive rocks. It is rarely that any considerable bodies of ore have been found in this belt inclosed in unaltered sedimentary rocks, or in fact in metamorphic rocks other than schists. They are not commonly separated from their inclosing rocks by sharply defined boundaries, but fade out by gradual transitions from ore in which there is more or less waste to rock in which there is more or less ore, and finally into rock with only a small percentage of disseminated sulphides. They are not often bounded along the sides by definite walls, though sometimes one wall is in evidence, emphasized as to its extent and importance by a selvage of clay and other similar material which testifies to a certain amount of either lateral or vertical movement. It does not always appear, however, that such walls have had any connection with the genesis of the ore. The ore bodies are not conformable in their extent to the directions of these walls, and it may be that the walls are only planes of shearing developed secondarily. One of the most clearly defined walls is along the eastern face of the ore body in the Shasta King mine, where it has been followed for a distance of at least 400 feet.

The western section of the Shasta copper belt contains the largest deposits of ore yet discovered in the county. The ore bodies of the Balaklala group are in some respects unsurpassed. The larger body extends over a space 700 by 500 feet in its greater dimensions, as proved by its present development. It lies in an inclined position, with a thickness of at least 50 feet, but its real extent has yet to be ascertained. Not all of the contents of this space is to be classed as ore, though the tunnels often extend through massive sulphide, with but little waste, for 100 or even 200 feet. In the Shasta



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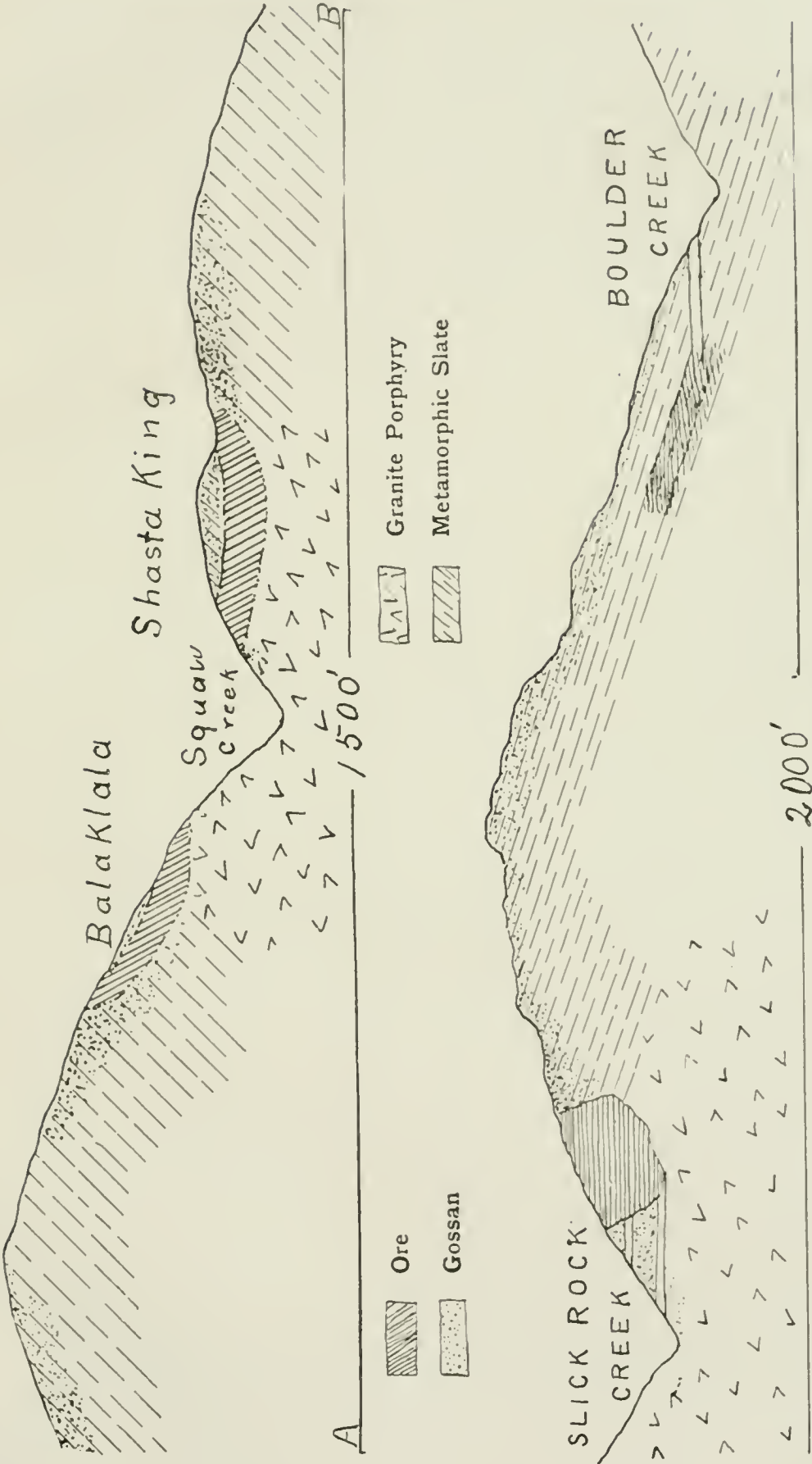
King mine a series of tunnels, approximately on one level, have penetrated an ore body which is shown to have a longitudinal extent of more than 400 feet, and a width near the apex of 100 feet, but whose depth has yet to be learned.

There are three types of ore deposits within the copper belt that require notice in this report, differing not only in their mineralogy and form, but also in their mode of origin, to a certain extent. These are: (1) Deposits of magnetic iron (magnetite), with pyrrhotite and pyrite; (2) Massive deposits of pyrite, chalcopyrite, and other sulphides; (3) Vein-like deposits of mixed sulphides, including a relatively large percentage of gold, silver, zinc, antimony, etc.

The first class of deposits occurs most abundantly to the north of Pitt River near the mouth of the McCloud. One and a half miles southeast of Baird very large deposits of magnetic iron occur, carrying a small percentage of iron sulphide, with some value in gold. Associated with them are smaller veins of copper ore. The largest deposit of magnetic iron ore at the head of Potter Creek can be easily traced for more than half a mile, and undoubtedly has a width in some places of more than 100 feet. Considerable bodies of this ore are strongly polarized. It is associated with bodies of actinolite and other iron-bearing silicates representing intense local metamorphism. The iron ores are for the most part connected directly with the diorite near its contact with the massive carboniferous limestones, though in some cases the ore is found in narrow dikes inclosed in the limestone itself. These ore bodies are evidently of eruptive origin, and probably represent extremely basic segregations from the eruptive mass.

The deposits of the second class are those of mixed pyrite, chalcopyrite, and other sulphides, which form the principal deposits of copper ore lying west of the Sacramento River. This class includes the ore bodies of Iron Mountain, Squaw Creek, Backbone Creek, etc. They are inclosed either partially or wholly in the metamorphic schists of the western districts, and are usually closely connected with the acid eruptives involved with them. These deposits appear to have been one of the results of metasomatic action attending the intrusion or extrusion of the acid eruptive rocks. Some of the deposits are found closely connected with rhyolitic flows.

The ore deposits of the third class are represented by those



GEOLOGICAL SECTIONS ACCORDING TO AVAILABLE DATA. THE UPPER ONE SHOWS THE BALAKLALA AND SHASTA KING FORMATIONS; THE LOWER SKETCH IS OF A SECTION OF IRON MOUNTAIN.

of Copper City, the Bully Hill, Afterthought, and other mines. In form they have some resemblances to irregular veins with a succession of ore shoots arranged along certain lines. Although in the manner of their origin and occurrence they are not thought to be different from the preceding, yet they are much more limited in extent, and are characterized by the presence of larger percentages of gold, silver, zinc, and antimony, and sometimes copper, together with barites as a gangue mineral. They have also a correspondingly low percentage of iron.

The alteration of these ores, especially those of the latter classes, is of special interest. Where surface erosion has exposed or truncated the ore bodies, there has usually been a large amount of oxidation and destruction of the sulphides. The oxidation and the formation of soluble sulphates have resulted in a leaching of certain metallic contents, which have been carried either downward or outward according to the direction of the drainage. Residual accumulations of metallic oxides is the rule, often forming thick crusts or masses of "gossan," or else only staining the rocks upon which it is deposited. The chief metallic element of the gossan is of course iron, though it very often contains a small percentage of copper, and it has often formed an ore of gold and silver, as in the Iron Mountain, Bully Hill, and Afterthought mines.

The term "gossan" appears to be only vaguely understood, and it has generally been applied in Northern California without discrimination between the thicker crusts of limonite and the more or less decayed rocks which are only stained with the same material. At Iron Mountain the iron oxide which has resulted from the decay and leaching of the ores has formed in some cases crusts of limonite many feet in thickness. These crusts have a bedded structure characteristic of materials deposited by water. There is comparatively little rock or earthy matter in some of these deposits, and it is evident that they are accumulations of iron oxide carried by means of water from ore bodies of considerable extent. Furthermore, it is evident that iron is one of the chief elements of the ore.

At Bully Hill the surface indications are very different, although the term gossan is likewise applied. Instead of thick crusts of limonite the surface is largely covered by broken and stained masses of rock, often light colored, but containing

generally some metallic oxides, perhaps including antimony or zinc. The rock is extensively decomposed and earthy, forming what is often termed "soft porphyry." Such croppings do not indicate an ore that is very high in its percentage of iron. The quantity of gossan found on the surface is generally taken as an index of the quantity of sulphide that has been affected by weathering, and accordingly of the quantity of sulphide that may be expected to be found by development.

As an index to the location of ore deposits, the material termed "gossan" is of great importance to the prospector, and a word may be added as to the forms in which it commonly occurs.

(1) There are residual masses of iron oxide *in place*, which have not been removed from the position of the decomposed sulphide.

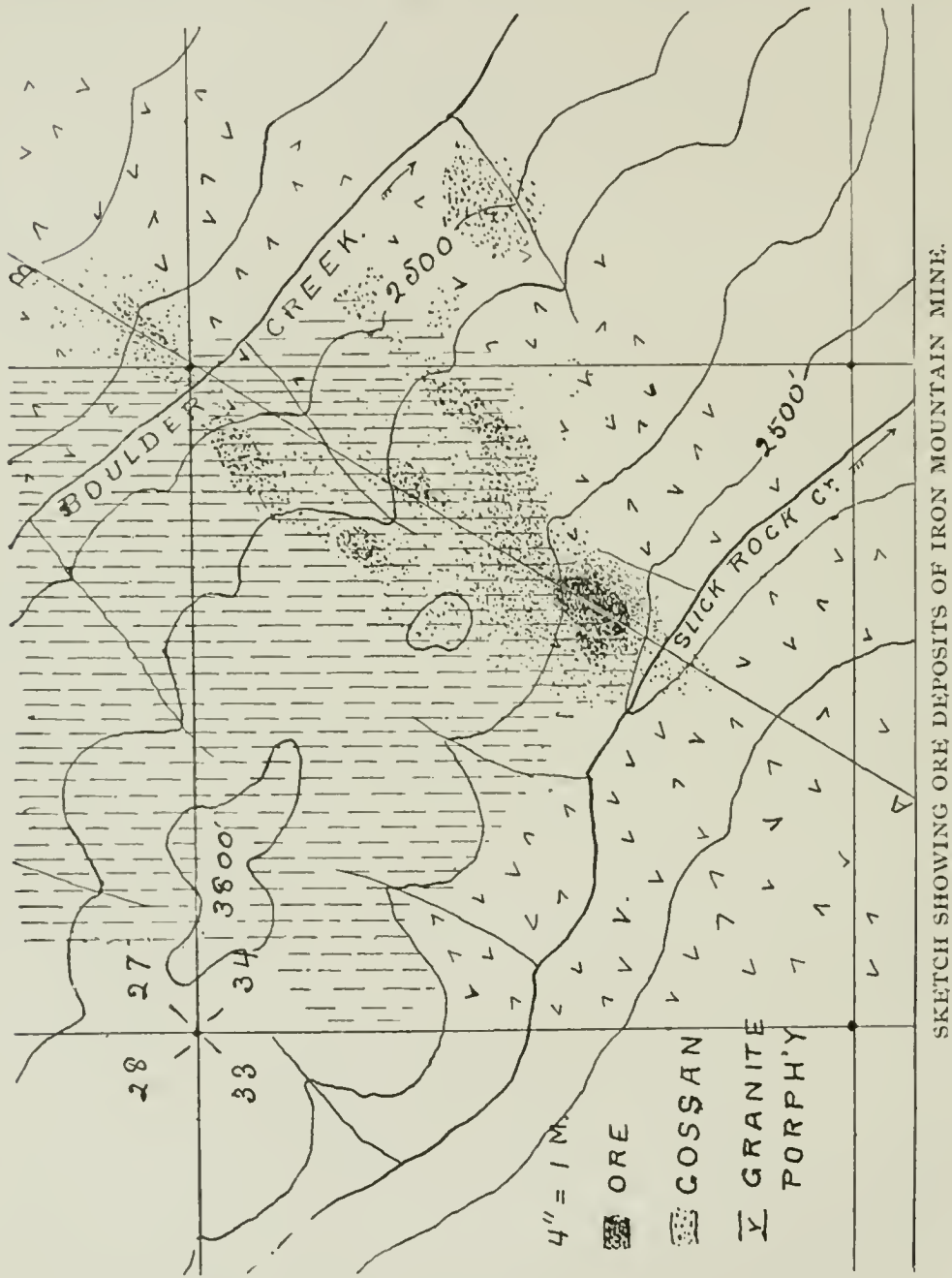
(2) Iron oxide is carried by circulating waters toward the surface or elsewhere, and deposited as crusts or beds of limonite.

(3) Iron oxide may merely stain the more or less altered country rock, becoming very deceptive as to the quantity and quality of the sulphides from which it has been derived. The sulphates that result from oxidation of iron sulphides react strongly on the country rock, reducing it to the form of white clay and fine white silica, but the oxide of iron may also stain this material to a brownish or dark color.

(4) Much of the so-called "gossan" of Bully Hill is only decomposed rock, consisting of silica and clay which is often only slightly stained with iron oxide.

Secondary enrichment in these ore deposits is very frequent. The leaching of the surface ores results in the formation of soluble sulphates and perhaps other compounds of the metals which are carried downward into the lower portions of the ore body, where richer sulphides are again precipitated. This appears to have been the origin of much of the chalcocite and of the chalcopyrite and other richer ores which are found below the zones of complete and partial oxidation. Such richer ores commonly have a banded structure showing clearly their secondary deposition, which the unaltered sulphides do not appear to have. The depth to which this secondary enrichment has extended varies with the conditions, no doubt. In the deposits of the Iron Mountain mine it extends to a depth

of 300 to 400 feet. In the Bully Hill mines the depth is possibly even greater. Below the zone of secondary enrichment the ores are usually of lower grade, consisting largely of the unaltered sulphides, which in themselves often become



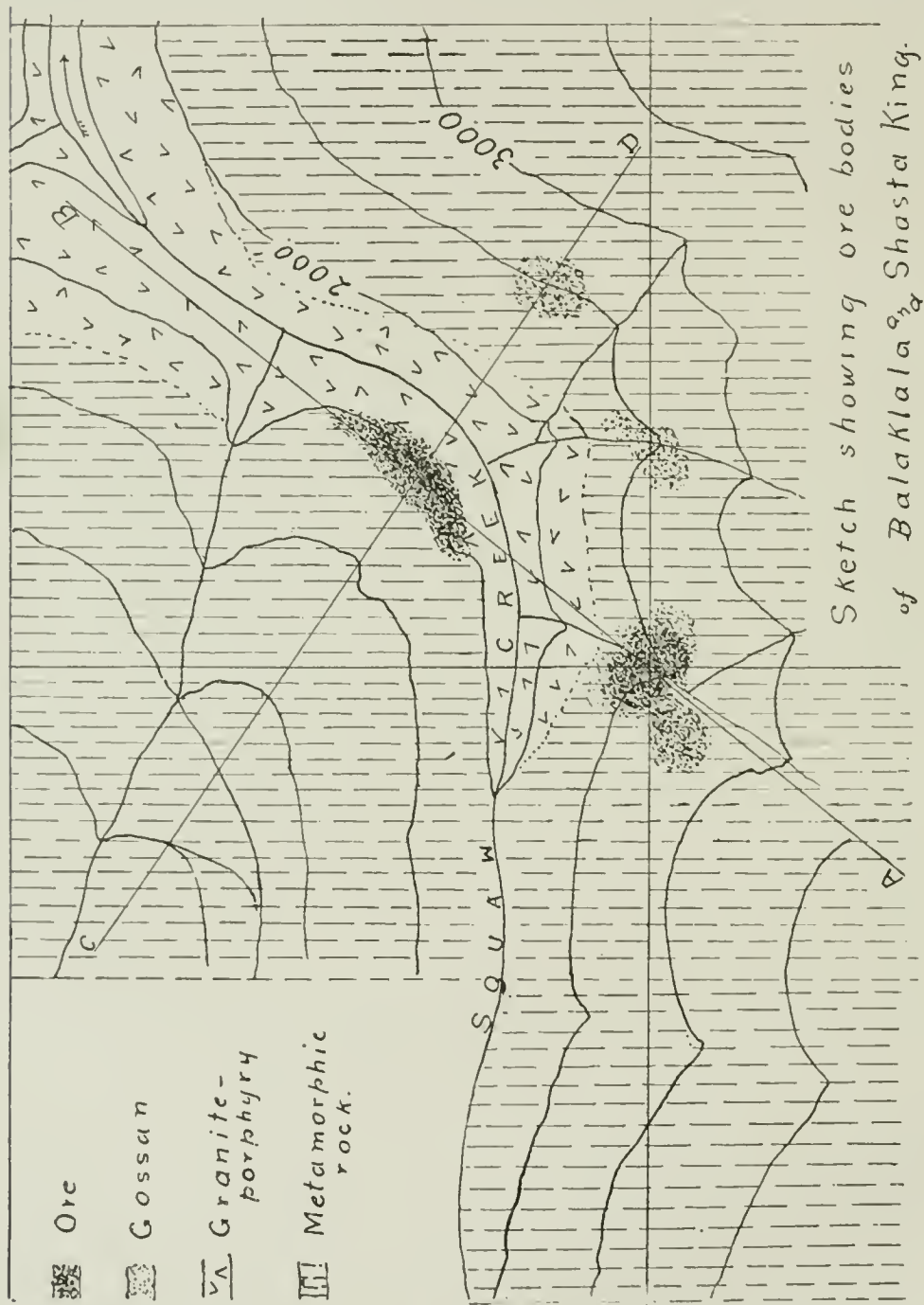
more sparingly distributed. The banding of the ores, that is the alternating darker and lighter bands that are often found in them, is probably the result of secondary action within the ore body, subsequent to the formation of the ore body itself.

The much talked of ore deposits of Iron Mountain deserve

to be particularly noticed in several of their aspects. The principal one of these lies on the southern slope of the ridge to the north of Slick Rock cañon, where its position and extent are superficially indicated by an impressive outcrop of gossan. This gossan consists of various materials, the most noticeable one naturally being the iron oxides. The oxides of iron occur as thick beds or crusts of limonite, or as infiltrations or stains mingled with more or less rock and earthy matter. The limonite accumulations have at some points a thickness of more than 30 feet.

As an ore body this deposit of sulphide is roughly lenticular in form, standing in a steeply inclined position, the upper border of which has been truncated by the slope of the hill under atmospheric erosion. The longest dimension of the ore body conforms to the strike of the rocks in which it is inclosed, and approximates a length of about 600 feet. Its course is northeasterly. Its vertical depth is something over 300 feet, and its greatest thickness about 250 feet. It has been described as being "egg-shaped," with its smaller end downward, but this is true only in cross-section. There is comparatively little waste rock contained within its boundaries, and for the most part it could be described as homogeneous sulphide. Therefore, its total tonnage of sulphide has probably exceeded that which has commonly been reported, yet not all of this is to be regarded as ore. In the several levels in which this ore body has been explored the sulphide is not of uniform grade. In an intermediate zone or level, generally spoken of as the "copper level," the ore consists of mixed pyrite and chalcopyrite, and has an average grade probably not below 7 per cent of copper; indeed, some portions of it carry a value above 12 per cent or even 15 per cent in copper. Above this zone is that of partial or complete oxidation, from which the copper contents have been largely removed by leaching. Below the "copper level" the ore is likewise of lower grade in copper, but in this case from a different cause. The "copper level" is a zone of secondary enrichment, below which such action has not been effected. The ore carries considerable value in gold and silver, its gold values ranging above \$5 per ton for large masses of ore. Probably none of the sulphide is without its gold content, even when it contains only a trace of copper.

Of the other ore bodies upon this property but little can be said. On the Hornet claim lying across Boulder Creek a large body of pyritic ore has been found which is of rather low grade. It has a thickness of over 150 feet, and lies in an inclined



position, as elsewhere shown. Regarding the formations in which these deposits occur, all that can be said now is that they appear to be inclosed in a somewhat talcose metamorphic schist, with which are associated granite-porphry and old

flows of rhyolitic lava. In some places the rhyolitic rocks have a decidedly brecciated character.

The mineralogy of the ore deposits is a topic for fruitful investigation. The deposits of the eastern and the western districts differ to some extent in their mineralogy as well as in the richness of their ores. Most of the ores of the western district are of lower grade than those worked at the Bully Hill mines, though at the same time they are of much larger dimensions. Large bodies of ore characterize the western district, while high-grade ores are more frequent in the eastern.

The ores of the Bully Hill mines are usually of a dark lead-gray color, in which the dark sulphides of copper and zinc often form the predominating elements. The same is true of the ores found in the workings near Copper City and in the mines of the Afterthought group. The ores contain zinc blende, chalcocite, bornite, chalcopyrite, tetrahedrite, melaconite, and carbonates of copper, with some native copper, silver, and gold. The gangue minerals are barite, calcite, quartz, and residual clay silica and iron oxide.

In the western district, the ores of the Balaklala, Shasta King, Mammoth, Summit, and Golinsky groups, and also of some others, are an intimate mixture of pyrite and chalcopyrite, with occasionally a little zinc blende and some carbonates. In the ores of Iron Mountain there are some of greater value including bornite and chalcocite. The gangue includes silicious materials, commonly known as quartzite, both east and west; but as the ores are not always connected with sedimentary beds, the silicious material is perhaps largely of a secondary nature.

The Iron Mountain ores comprise the oxides at and near the surface and the deeper-lying sulphides. The oxides carry but a very small percentage of copper, their main values being in gold and silver, for which these ores were at one time worked. They consist principally of ferric oxide, accompanied by a little silica and alumina. Analyses of trial lots have afforded the following:

Sulphur	13.41	2.49
Iron in FeS ₂	11.40	2.09
Ferric oxide	48.22	70.88
Zinc	0.24	0.21
Silica	9.45	8.57
Alumina	0.60	1.39
Water	14.00	13.43

The sulphides, which carry as much as 10 per cent of copper in some parts of the mine, are much poorer in gold and silver. One lot of sulphide ore, consisting of 754 tons, smelted in 1896, assayed partly as follows:

Sulphur	45.66
Iron	36.97
Zinc	3.41
Silica	5.60
Alumina	1.57

The total of these figures being only 93.21 per cent, it may be inferred that the remaining 6.79 per cent consists mainly of copper and the precious metals.

Regarding the composition of the ores of the Bully Hill mines less is known, but it is clear that their content of iron is comparatively low, rendering a ferruginous flux necessary, and there is a corresponding increase in the percentage of zinc, with barytes as a gangue mineral. Antimony and arsenic are also present, though to what extent is not known.

The ores of the Peck, Afterthought, and Donkey mines in the Cow Creek district, which in many respects resemble those of the Pittsburg district, are described as being "very refractory." William Kemp, who superintended the last attempt to smelt the Afterthought ores, states that of the 200 tons of ore which was smelted in 1896, 60 tons contained $6\frac{1}{2}$ per cent zinc and 11 per cent heavy spar; 100 tons contained 16 per cent zinc and 6 per cent antimony; and that about 30 tons of partly oxidized iron and copper ore contained 10 per cent zinc. He adds: "From this ore there were 32 tons of copper matte produced, containing, according to the sample and assay, * * * the following contents: copper, 37 per cent, forty-five ounces of silver and \$7 gold per ton." The average grade of this ore was about 5.9 per cent copper, and did not therefore represent the better ores of the district.

MOUNTAIN COPPER MINE.

The Mountain Copper Mine, sixth in rank in the United States in point of copper production and the pioneer copper mine of the Shasta County copper belt, is the old Iron Mountain Mine, in the familiar mountain of that name, located between Slick Rock and Boulder creeks, a few miles west of the Sacramento River, in Sec. 34, T. 33 N., R. 6 W. The

property included in the mine proper embraces a number of patented mining claims on the top and sides of the mountain and in the creek cañons. The mountain is here about 7000 feet wide, between the creeks named. The summit of the ridge has an altitude of 3000 feet, and Slick Rock Creek is 700 feet lower. On the apex of the mountain stands a bold outcrop of gossan 300 feet wide, and wide branches of these croppings of iron oxides occur in irregular belts extending laterally toward Boulder Creek.

These gossan ores, from which the copper has been leached out, carry the silver and gold values which prompted and sustained the long and costly efforts at precious-metal mining, of which an account is given in the historical chapter of this bulletin. The quite extensive development of the mine in former years had silver mainly in view, and the tunnels then run had not quite reached the copper sulphides, which remained to be discovered by later explorations. It was as a silver mine that the property was long on the market until taken hold of in 1895 by a syndicate of London people, who incorporated the Mountain Mines Syndicate, Ltd. This company extended one of the prospect tunnels, encountered and developed a great body of sulphide copper ore, and proceeded to operate the property as a copper mine. Capital was liberally invested in mining facilities, a smelting plant, and a refinery in New Jersey, and the property was, in less than two years, in profitable and successful operation. This discovery and the success that early followed the large-scale operations, first called wide attention to the copper resources of the great mineral belt to which the mine belongs, and were the start of copper mining in Shasta County. January 1, 1897, the entire property of the Mountain Mines Syndicate was transferred, for \$5,750,000, to the present Mountain Copper Company, of London, composed of practically the same individual interests, and with a capital stock of £1,250,000, or about \$6,250,000.

The ore deposits of Iron Mountain, specifically described in the section on "The Geology of the Copper Belt," consist of immense lenticular masses of sulphides, mainly underlying the gossan, but in places in and under rhyolite, with no surface indications above. The principal ore mass developed lies in the southern side of the mountain above Slick Rock Creek, and from it the larger portion of the ore mined has come.

This ore body was found to be approximately 800 feet long, 100 to 400 feet wide, and 600 feet deep at its greatest depth below outcrop, and was estimated to contain about 1,700,000 tons of ore of all grades. On the opposite side of the mountain a somewhat similar ore body has been partially developed, and it is reported that the latest developments show that these bodies are connected by ore extending clear through the mountain. At the date of the transfer to the Mountain Copper Company the ore reserves in sight were estimated at 1,333,183 tons, and other ore bodies have since been developed. The total tonnage of ore mined aggregates nearly 1,000,000 tons, and the existing reserves, indicated by present development, are reported to exceed 1,000,000 tons. The ores are massive iron pyrites carrying an average percentage of copper, which, in the ore smelted to date, has declined from 7.45 in 1897 to 5.77 in 1900, and a little less than 5 in the first six months of 1901. The decline in the average is due partly to the partial exhaustion of the ores in the zone of secondary enrichment and partly to the mining of lower-grade ores formerly left in the mine and now made available by increased efficiency of mining and reduction and the enlargement of the capacity of the smelting plant. The ores carry a large percentage of sulphur, a small amount of silica, and are exceptionally free from arsenic, bismuth, and other elements detracting from the electrical conductivity of the copper. The average precious metal values are understood to be a little less than \$1 in gold and approximately 2 ounces of silver per ton.

The mine is opened by thousands of feet of tunnels driven from points high up the sides of the hill, and the ore has been stoped from a large portion of the ore body on the south side. The resulting chambers, instead of being timbered, have been filled with waste rock taken into the mine from the surface as fast as the ore was removed, and the mine timbering has been thus practically limited to the working tunnels. Three diamond drills are included in the equipment, and they have been extensively used in explorations both in Iron Mountain and in adjacent properties owned, or prospected under bond, by the company. The numerous buildings at the mine used for all purposes are grouped in Slick Rock Cañon below the mine. The mining plant includes air-compressors for operating power drills, and an electric railway for transporting the ore



SMELTER OF THE MOUNTAIN COPPER COMPANY, KESWICK, SIASTA COUNTY

from the mine to the bunkers at the mine terminus of the steam railroad running to the smelting plant. The latter road is a narrow-gauge line equipped with five locomotives, necessary cars, and a complete repair shop. It is eleven miles long, extremely tortuous in its course, and descends a grade of nearly 2000 feet between the mine and smelter. At the latter place the ore-cars dump from a trestle twenty feet above the level of the yard. At the mine the cars are loaded in a tunnel, into which chutes lead from ore-bunkers on the hillside. About 250 men are employed at the mine.

Owing to the topography of the country no location suitable for a smelting plant could be found nearer to the mine than a point several miles down Slick Rock Creek, and a little over a mile west of the Sacramento River. Here the company at the start established the reduction plant, which has been expanded to its present scale and about which the flourishing town of Keswick has grown up. The private railroad extends to the Southern Pacific line at the river. The smelting facilities include five water-jacket blast furnaces, one brick hot-air stove to supply hot-air blasts, one Ropp roasting furnace, eleven Wright circular calcining furnaces, three briquetting machines, a three-stand converter plant, a sampling plant, and other necessary adjuncts. An extensive foundry and machine shop are among the other features. The present capacity of the plant is 1000 tons of ore per day. Most of the 1200 employes of the company are employed at the smelter.

When reduction was first attempted in 1896, the pyritic method was tried, under the direction of Herbert Lang. This method was soon abandoned and the ordinary blast furnace method in general use in Montana was adopted. The new plant was installed by H. A. Keller. The capacity was at first 250 tons per day. This has been quadrupled by successive enlargements and additions, and to-day the plant is a model of modern and efficient equipment and practice.

The ore, as it comes from the mine, carries about 45 per cent of sulphur. Until 1899 the raw ore was roasted in stalls to remove a large percentage of the sulphur, but in the year mentioned heap roasting in the open air was substituted and has since been the practice. The time allowed for heap roasting is usually from 60 to 70 days. This leaves about 16 per cent of the original sulphur content in the ore, making the roasted

ore carry about 7 per cent of sulphur as it goes to the furnace. A large percentage of the ore, including the fines, is roasted in the mechanical rotary calcining furnaces which are the patented invention of Lewis T. Wright, who has been general manager of the properties and operations of the Mountain Copper Company in California for five years.

The roasted ore in the outdoor heaps is loaded into cars with steam shovels and transported to the blast furnaces. The plant is arranged on the one-level plan, the site not permitting the terrace arrangement which facilitates the handling of material.



MCDUGAL ROASTING FURNACE, KESWICK SMELTER, MOUNTAIN COPPER COMPANY, SHASTA COUNTY.

The ore floors, cupolas, roasters, etc., are all upon one plane, and hydraulic elevators are used for hoisting to the charging floors, though some of the ore is conveyed directly to the cupolas on elevated tracks. The ore cupolas produce a low-grade matte, probably containing 20 to 30 per cent of copper, and this is in part subjected to another roasting before going to the matte furnaces for still further reduction. The fines from the calcining furnaces, together with the flue dust and other similar material, are bricked by the briquetting machinery for reduction in the various furnaces. Until recently the matte finally produced was shipped as such to the company's refinery

at Elizabeth, New Jersey, and the grade of the matte produced by the furnaces has steadily risen, through improved processes and repeated concentration, from 45 or 50 per cent in 1897 to about 80 per cent at the present time. At about the beginning of the present year a bessemerizing plant was completed and put in operation, and the final product now sent to the refinery is blister copper, probably 98 per cent fine.

Early in 1902 electric light and power for both smelter and mine began to be supplied by the Keswick Electric Light and Power Company from its generating plant on Mill Seat Creek, 40 miles southeast of Redding, and about 55 miles from the mine. Crude petroleum has for a good while been used for generating steam power and in the hot-air blasts. The cost delivered is about \$1 per barrel, and about 300 barrels per day were used before electric power was installed. The company owns a large area of timber land on the Pitt River 65 miles from Keswick, and the timber and wood supply is floated down the Pitt and Sacramento rivers to near Keswick. Water for use at the smelter is pumped from the Sacramento River. The company has also extensive holdings of land in the general region of the mine and smelter. Some of it was acquired for its timber, some for its possible mineral values, and some on account of the destructive influence on vegetation of the sulphur fumes from the burning ore-heaps and the smelter. These fumes have killed vegetation through a large adjacent region and this has given the company some trouble; but in justice to the industry it may be said that the destruction is less serious than it would be in many other districts, owing to the trifling extent to which agriculture is carried on in that particular neighborhood and to the small size and low value of the trees of the region.

Many details of interest are necessarily absent from this sketch of the Mountain Copper Company's properties and operations, owing to the limited information afforded the public by the company and its rule that the officers shall not discuss its business. Its annual reports, however, afford a general knowledge of its operations and give the financial information which measures its success. Production began early in 1896, and during that year 5663 tons of fine copper were produced.

The copper production of the four following years is stated by these reports as follows:

	1897.	1898.	1899	1900.
Ore extracted, tons.....	165,060	221,895	203,965	179,694
Ore smelted, tons.....	97,185	168,514	176,689	207,571
Copper matte, tons..	7,238	10,721	10,664	11,978
Copper refined, tons.....	5,958	8,273	11,388	11,443
Copper sold, tons.	6,025	8,273	9,647	10,558
Average per cent copper in ore.	7.5	6.33	6.04	5.77

It was semi-officially reported that during the first six months of 1901 the amount of ore smelted was 172,783 tons, which would represent something over 8000 tons of fine copper. The quantity of ore smelted during the first half of 1901 was over 80 per cent of the total quantity for the previous year, and had this rate of production been continued through the year a very large annual increase would have resulted. A fire in the mine and other circumstances caused a large falling off in the output of the last six months, however, and the total record for the year, when officially announced, will probably be about equal to that of 1900. The available figures indicate a total of approximately 925,000 tons of ore smelted during the six years of operation, with an approximate total output of 54,195 long tons of fine copper. This is equal to 121,396,800 pounds.

Custom smelting has been practiced at Keswick since the earliest operations, but mainly upon silicious gold ores. Only to a limited extent have copper ores found their way to these works, except from adjoining counties. Most of the custom work has been for the purpose of obtaining the silicious material required as flux by the smelters themselves. Gold concentrates have been treated generally, but this patronage is not solicited. The following advertised custom tariffs of the Mountain Copper Company show the charges on different grades of ore:

According to the grade of the ore, the following per cent of the gold assay value of gold quartz ore is returned: From \$2 to \$15, 75 per cent, with no smelting charges. From \$15 to \$25, 77½ per cent; no smelting charges. From \$25 to \$50, 90 per cent; smelting charges, \$3.50 per ton, wet weight.

From \$50 to \$75, 90 per cent; smelting charges, \$5 per ton, wet weight. From \$75 to \$100, 90 per cent; smelting charges, \$7 per ton, wet weight. From \$100 to \$200, 90 per cent; smelting charges, \$10 per ton, wet weight. Less than 5 ounces of silver per ton not paid for. For high-grade concentrates, 90 per cent of the assay value in gold and silver is returned, with an additional charge of \$12 per ton for smelting.

In receiving copper ores, from the electrolytic copper assay, one unit, or one per cent, is deducted to cover losses, and then on the basis of the reduced assay the tariff is fixed according to the grade of the ore and the market value of copper. In all cases a smelting charge is made according to the character of the ore, and an additional charge of \$3 is attached for shipments in less than carload lots. Silicious gold or copper ores are always in demand. The ores sent to the smelter from a single district in the vicinity amount to not less than 600 tons per month and probably more, mainly silicious gold ores. About 75 per cent of the silicious ores used for fluxing are custom ores. About twenty mines ship regularly, half or more of them being in the Old Diggings district across the river. The ore is carried across the Sacramento River by a cable tramway, and is thence taken by rail to the smelter, at a cost of about 25 cents per ton. Cheap transportation to a convenient smelter here permits the profitable mining of relatively low-grade ores.

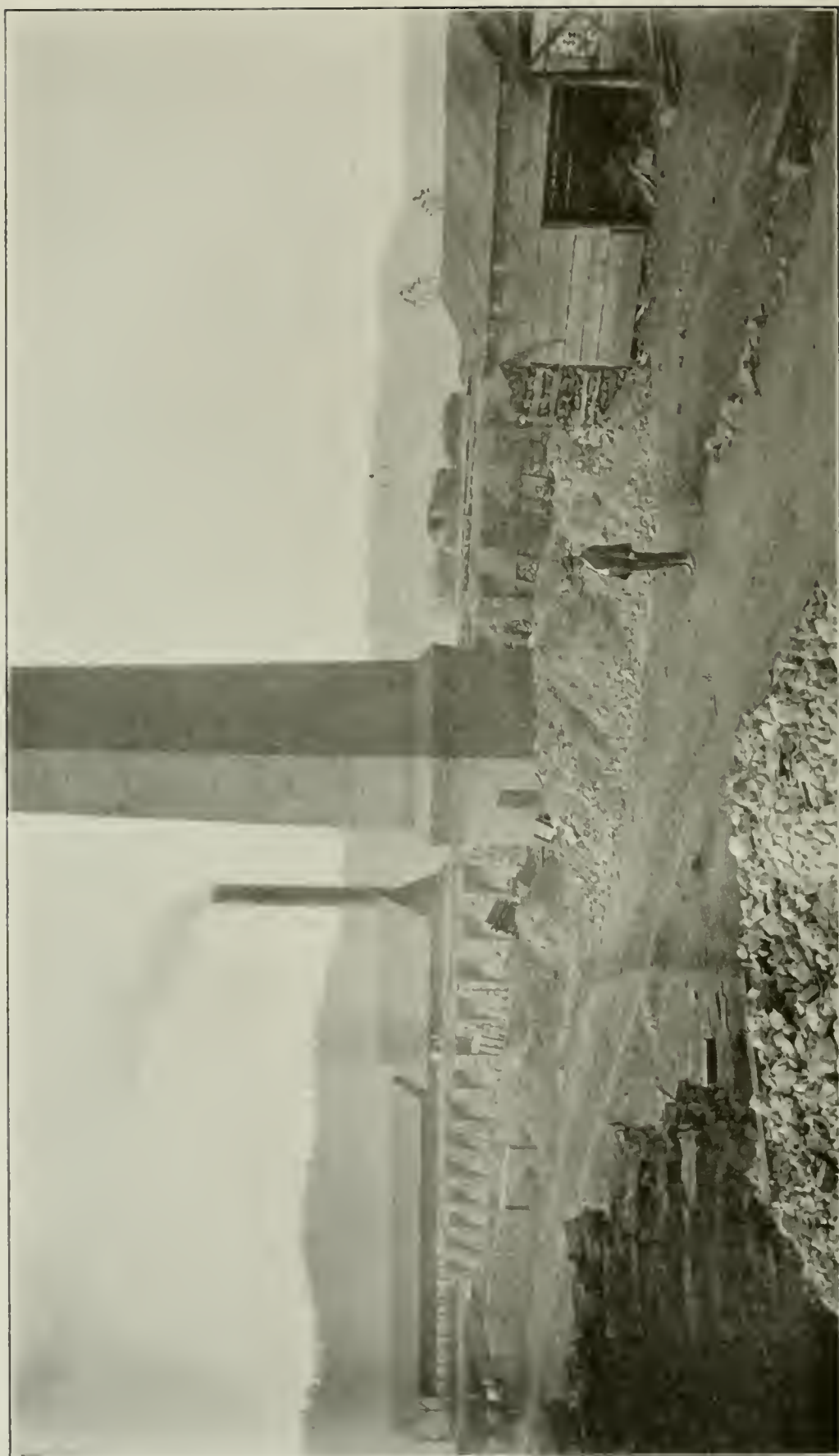
Owing to the exceptionally low percentages of arsenic, antimony, etc., the refined product of the Mountain Copper smelter commands a premium in the market for electrical uses. Its conductivity is rated at 101, or more than the standard previously fixed for copper commercially recognized as pure. A paper by Edward Keller, in *Mineral Industry* for 1900, affords an analysis of a sample of copper matte from the Mountain Copper Company's smelter, giving the following composition by percentages: Copper, 57.83; sulphur, 22.47; iron, 15.28; nickel and cobalt, .005; zinc, 2.09; lead, .0719; bismuth, .0014; antimony, .0719; arsenic, .013; tellurium and selenium, .006; silver, 13.4 oz. per ton; gold, .51 oz. per ton. This matte, of course, carries the products of fluxing materials. An analysis of the refined product is not available.

BULLY HILL MINE.

This property, situated nearly twenty miles in a direct line north of east from Iron Mountain and well toward the eastern end of the copper belt, is the second producing copper mine of Shasta County, and the second in importance in the State. The Bully Hill is an old property, which, like the Mountain Copper, was long ago and for a good while mined, with little or no success, for the gold and silver in the gossan near the surface. During the first years of the operations of the Mountain Copper Company this property underwent extensive exploration, which developed important ore bodies justifying the expensive further development and the installation of mining and smelting plants which followed.

The Bully Hill property includes seventeen lode claims and one placer claim, all patented, aggregating 213 acres. It stretches for about two miles in a northeasterly direction, close to Squaw Creek and but a little north of Pitt River. It is in Secs. 15, 16, 21, 22, and 28, T. 34 N., R. 3 W. It is near the old town of Copper City, and the new town Delamar adjoins. About three years ago, on the strength of the showing made by tunnels driven by James Sallee, the property was bonded by J. R. De La Mar, and after further development was purchased by him for \$225,000. In 1901, the property was transferred to the Bully Hill Copper Mining and Smelting Company, of which Mr. De La Mar is president.

The owners give but little detailed information about the mine. It is in a zone containing irregular vein-like formations, capped with gossan, the veins trending east of north. Their dip is nearly vertical. The principal Bully Hill veins occur as fissures in meta-rhyolite as classified by the U. S. Geological Survey. Two main parallel ore bodies have been exploited in the lode claims and one in the Popejoy placer claim. The width of the veins varies from 4 to 100 feet, and averages 30 feet. The ore lies in lenses connected by narrow seams of ore. Four tunnels have been driven into the hill, and the openings comprise several thousand feet of tunnels and drifts, with extensive stopes and upraises. The lowest tunnel level is about 600 feet below the outcrop, and through this level, No. 3, most of the ore mined is taken to the surface. The tunnel is driven as a cross-cut, and encountered the main vein at a point



ROASTING STACKS OF THE BULLY HILL SMELTER, SHASTA COUNTY

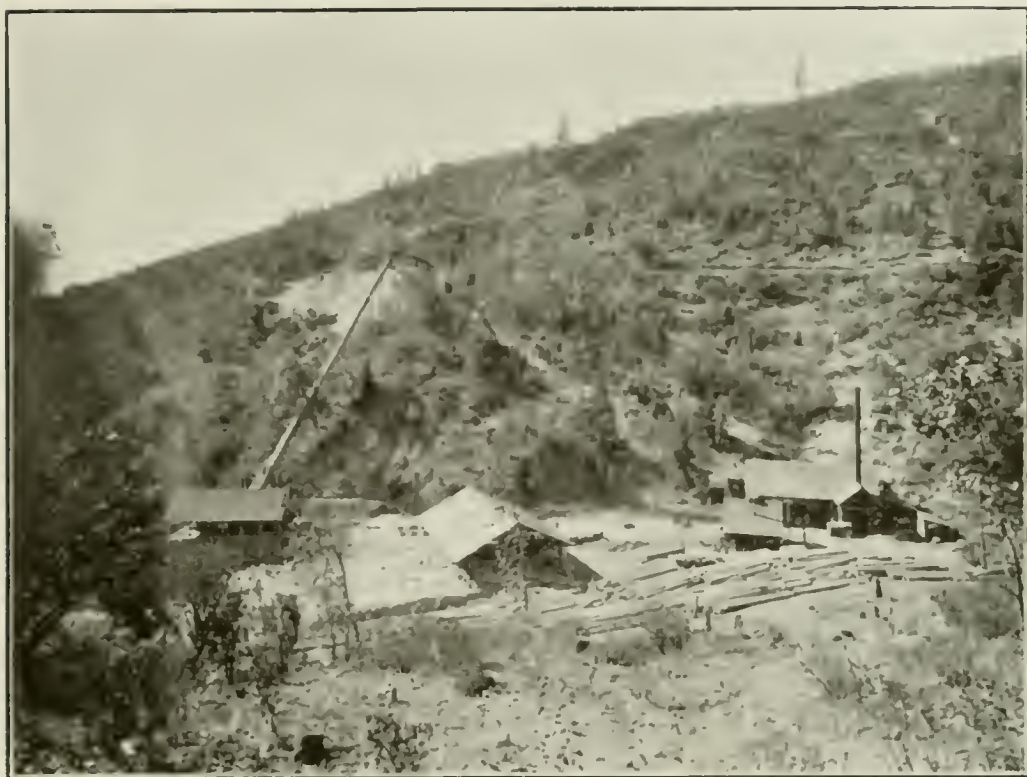


SMELTER AT THE BULLY HILL MINES, SHASTA COUNTY

about 1100 feet in. This level is connected with the upper workings, and the vein has been developed by means of drifts on the main levels for fully 800 to 1000 feet. At the point where the vein has been encountered on No. 3, a station 100 feet square has been cut, and extensive hoisting and pumping machinery is being installed for the purpose of continuing exploration at greater depth. A shaft has been started from this station on No. 3, and is down over 100 feet. In drifting from this shaft northeasterly a body of ore, which is developing into unusual importance, was encountered. The ore at this depth is a chalcopyrite, and will supply the iron which, until this depth was reached, was inadequate for the proper smelting of the product of the mine. In the upper levels, copper oxide (cuprite) and copper carbonates (malachite) occur. In these levels, however, the so-called "black ore," a copper glance, predominates, and supplies most of the ore at present reduced. It is believed that the ore encountered in the drift from the shaft below No. 3 approximates what will prove to be the unaltered character of the ore.

The mine is timbered by the square-set system. Mining timbers are floated down Pitt River from the timber region to the northeast, as is most of the cordwood used for fuel at the power plants and in the roasting stalls. The values of the ores are not reported, but it is stated on good authority that a large amount of ore of high grade in gold and silver as well as copper has been developed, and that the precious metals constitute about half the value of the matte so far produced. The ore is base, carrying zinc, antimony, etc. While there is much high-grade ore in the mine, it is understood that the ores are mixed and reduced on a basis of an average copper value of 10 per cent.

The lowest tunnel is connected by a railway with the well-equipped smelting plant one mile distant, which began operations in May, 1901. The raw ore is first roasted in stalls built on the hillside near the smelter. The series of stalls constitute a stone structure 39 by 310 feet, with a brick stack 90 feet high connecting with the stall flues. The smelting plant cost about \$200,000, and includes one water-jacket blast furnace, two calcining furnaces, five converters in two stands for bessemerizing the matte, a machine shop, etc. The furnace is 42 by 120 inches in size. The furnace charge usually consists



CHUTE BETWEEN TUNNELS Nos. 2 AND 3, ELECTRIC POWER HOUSE, AND
TIMBER SHEDS, BULLY HILL MINES.



VIEW OF BULLY HILL SMELTER FROM MOUTH OF No. 3 TUNNEL.

of about one half raw and one half calcined ore, the percentages varying with the nature of the ore. The charge carries 8 to 10 per cent coke, 2 to 3 per cent limestone, 1 to $1\frac{1}{2}$ per cent ironstone, and the balance ore. Limestone and ironstone for fluxing are obtained on the McCloud River about six miles distant. Sufficient silica is obtained from the mine. The furnace produces a matte carrying from 35 to 55 per cent copper, which is taken directly to the converters in a ladle handled by an electric crane having a capacity of 20 tons. The converters are 68 by 98 inches in size, and have a capacity of 5 tons. The product of the converters is blister copper, about 98 per cent fine, which is cast into large rectangular slabs for shipment to the new refinery built by Captain De La Mar on Kill von Kull, near New York City. Mining and reduction costs, values, and output are not obtainable. The capacity of the smelting plant is about 150 tons a day. The smelter is arranged on the terrace system, and throughout the process the material is economically handled by the aid of gravity.

The Bully Hill Mining and Smelting Company has purchased and bonded other properties on the belt, and it is reported that its plans include a large expansion of its scale of operations. Its most important additional property is the old Baxter and Winthrop group near Copper City. This property ranks fourth along the whole belt in the amount of development, and as soon as railroad connection with the smelter makes the economical transportation of the ore possible, active operations on these properties will be resumed.

OTHER PROPERTIES.

The remaining properties of the copper belt are noted successively, beginning at the western end.

Mineral Mountain.—This property consists of six unpatented claims about three miles south of Iron Mountain, in Sec. 13, T. 32 N., R. 6 W., and is thought to mark the southwestern terminus of the belt. No other mining claims carrying copper deposits worthy of any note are known to exist south of the Mountain Copper mine in Iron Mountain. The Mineral Mountain group is owned by D. T. Callahan et al.,

and about 200 feet of tunnel shows sulphide ore. There are surface indications of other bodies.

Sugar Loaf (Galvin) Group.—This property is located immediately northeast of the holdings of the Mountain Copper Company, and shows the first prominent outcrop on the belt after leaving the Iron Mountain mines. The property consists of fourteen claims located in Sec. 26, T. 33 N., R. 6 W. Sugar Loaf Mountain, which is covered by these locations, is one of the most prominent landmarks of the copper belt. The formation is the same as that encountered elsewhere on the belt. Large cappings of gossan indicate the presence of ore bodies in the rhyolitic rock, the main outcrop being over 400 feet wide. The property has been developed by a series of tunnels aggregating 1300 feet in length. The main development is on the north slope, where sulphide ore of a good grade has been encountered. On the southerly slope a tunnel 200 feet in length is near its objective point. Sugar Loaf Mountain undoubtedly contains large bodies of sulphide ore. It is situated directly on the main copper belt and the surface indications are very extensive. C. D. Galvin, owner.

King Copper Group.—The King Copper group, consisting of twenty-two claims in Secs. 23, 24, 25, and 26, T. 33 N., R. 6 W., adjoins the Sugar Loaf on the northeast and is the property of the Trinity Copper Company. It is located two and a half miles south of the Shasta King, the main Trinity Copper Company holding. The development so far done consists mainly of assessment work and approximates 1000 feet of openings in the aggregate. No ore in place has been developed as yet.

Jumping-Jack.—Five claims adjoining the King Copper on the east, in Secs. 24 and 25, T. 33 N., R. 6 W., owned by William Kendrick, of Copley. No development.

Giant Consolidated.—Thirteen claims on the eastern edge of this part of the belt, north of the Jumping-Jack, in Sec. 24, T. 33 N., R. 6 W., and Sec. 19, T. 33 N., R. 5 W. Little development. Owned by W. H. Soderberg et al., San Francisco.

King.—Four claims in Sec. 24, T. 33 N., R. 6 W.; owned by J. R. King, of Copley. No development.

United Copper.—Eighteen unpatented claims in Sec. 23, T. 33 N., R. 6 W., adjoining the King Copper on the north and west. Development consists of only 50 feet of openings. Owned by Fred Grotefend et al., Redding.

Webster Consolidated (Stowell) Group.—The Webster Consolidated, or Stowell, group consists of seven patented and three unpatented claims, located in Sec. 14, T. 33 N., R. 6 W. The property is one of the older mines on the West Side belt and is about three and a half miles northeast of Iron Mountain. The development consists of a series of short cross-cut tunnels aggregating 500 to 600 feet in all, none of which has reached the objective point. The main cross-cut is about 80 feet in length. This has been extended some under bond, but the vein has not been reached. The work is distributed over the various claims, and while the surface indications are strong, the fact that exploration was not concentrated at one point leaves the property as yet in practically a prospective position. The J. H. Stowell Estate, owner.

Waters Group.—The Waters group is located in Sec. 14, T. 33 N., R. 6 W., and consists of four claims. They adjoin the Webster Consolidated on the south, and some of the development work done was intended to reach the vein on the neighboring property at greater depth. Its location is such that it will prove of value to the adjoining holdings and when developed the properties will probably be operated as one mine. L. Waters and E. A. Marshall, of Redding, owners.

Spread Eagle.—Twenty-two unpatented claims in Sec. 13, T. 33 N., R. 6 W.; owned by W. C. Onn & Sons, of Copley. About 1500 feet of tunnels, mainly driven by the Scottish-American Syndicate, of Denver, Col., under bond, show considerable bodies of ore, including some of excellent grade. The country rock is heavily charged with sulphides.

Loraine.—Twenty-two claims adjoining the Spread Eagle on the northeast, in Secs. 7 and 18, T. 33 N., R. 5 W.; owned by J. R. Doyle et al., of Copley. No development.

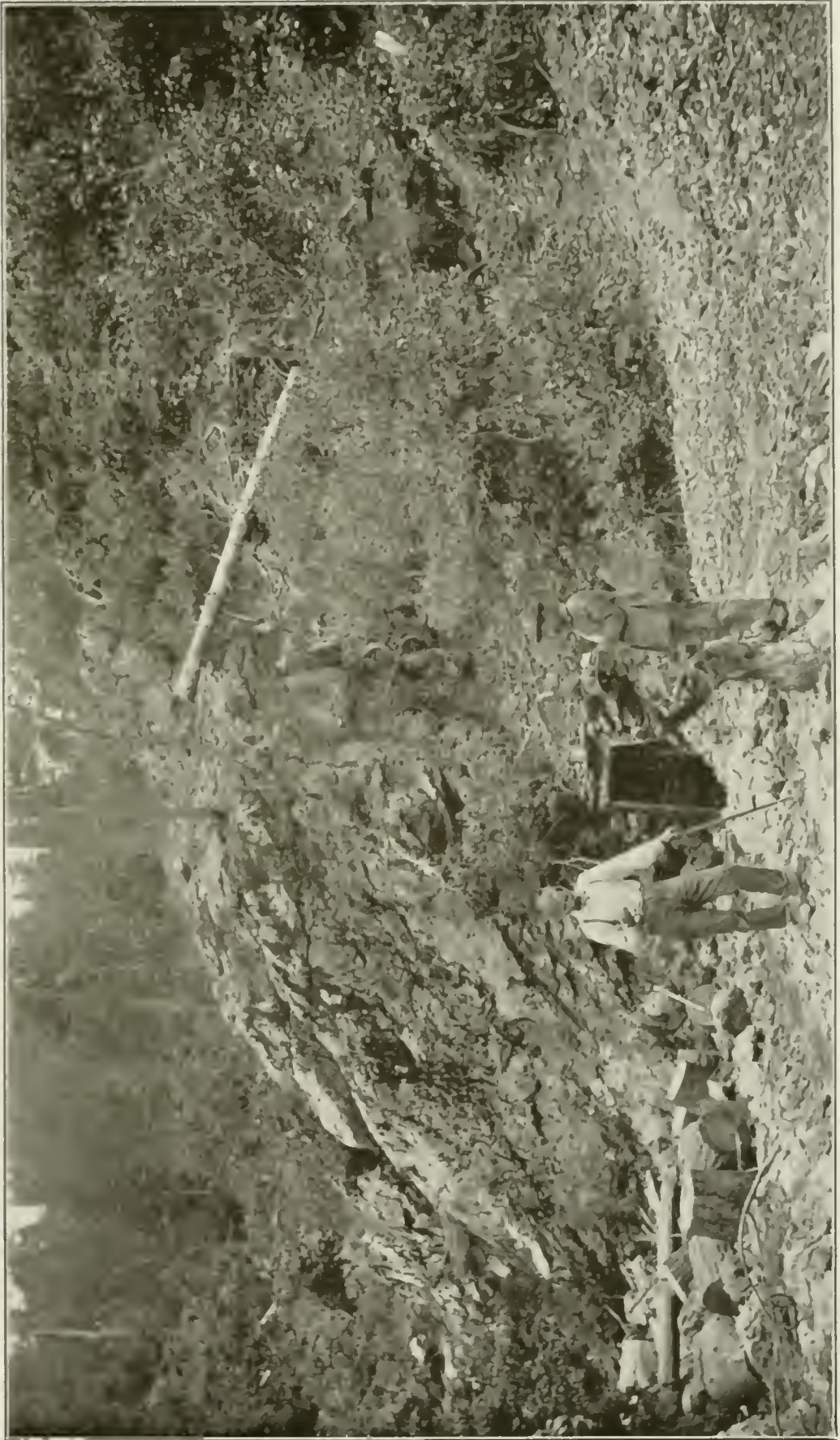
Shasta King.—The Shasta King mine constitutes the principal holding of the Trinity Copper Company, and is located in Sec. 12, T. 33 N., R. 6 W. The main portion of the property consists of twelve patented claims, but the company



SHASTA KING MINE OF THE TRINITY COPPER COMPANY, SHASTA COUNTY

owns a large area of adjoining land in addition. The Trinity Copper Company is a Boston corporation (Thomas W. Lawson, president), and is capitalized for \$6,000,000. It acquired the Shasta King mine toward the close of the year 1900, and early in the following year commenced development work on a large scale. The property was developed under bond for a year and a half prior to its purchase by the Trinity Copper Company, and at the time that it was acquired it is estimated that 1,200,000 tons of ore were opened up in the mine, which returned an average of 5 per cent copper and about \$2.50 to \$3 in gold and silver. The measurements have been considerably added to since. The property is opened up mainly by tunnel levels, aggregating at the present time fully 4000 feet in length. A series of tunnels cross-cut the ore body on the main level for a distance of 1000 feet around the mountain side, and these have been connected by drifts along the foot wall. A lower level is being driven (which will be utilized as the main working tunnel) 175 feet below the present main developments. This tunnel is 7 by 8 feet in size and double tracked. The surface improvements at the mine consist of the necessary buildings for the use of the miners, offices, store, postoffice, etc. Power drills are used, and a 6-drill air-compressor is part of the mine equipment. Considerable prospecting on unproved ground by means of a diamond drill has been prosecuted by the company. The headquarters building for the company is located at Kennet, near the smelter site. The site selected is in Sec. 3, T. 34 N., R. 5 W., on Backbone Creek, distant about eight miles by railroad from the mines. Grading on the site has been in progress and the railroad grade for a spur connecting with the Southern Pacific Railroad is now being put in. The reduction plant will be from 500 to 700 tons daily capacity. The Shasta King mine is located on the south fork of Squaw Creek and directly adjoins the Balaklala holdings. Its main workings are the lowest in altitude so far developed on the West Side copper belt. Austin H. Brown is general manager for the company.

Balaklala Mine.—The Balaklala mine at present shows the largest body of ore available in any one property on the copper belt of Shasta County, and prospecting done by means of the diamond drill indicates the possibility that it will develop



GOSAN CROPPINGS AND TUNNEL, BALAKIALA MINE, SILASTA COUNTY

one of the largest ore bodies of its kind on the American continent. The property consists of twenty-six claims, thirteen of which are patented, lying mainly in Secs. 12, 13, and 14, T. 33 N., R. 6 W. Adjoining ground will bring the total number of claims held by the Balaklala Mining Company up to sixty or more. The work has been done principally upon five claims from Huckleberry claim southwest to Windy Camp. The outcrop can be traced along this line for fully one and a half miles, and gives evidence of the magnitude of the lode for the entire distance. The greatest reserves of ore at present exposed are on the El Capitan claim. The main level, 400 feet below the apex, shows a thickness of from 60 to 100 feet. The dip of the lode is with the mountain to the northwest, and at the point where the greatest development work has been done the lode has been laid bare by erosion. As a result the copper values have been leached from it to a great extent, leaving the ore low grade in copper. On the strike of the lode where this condition does not prevail the ore has increased in value until it can be termed a good grade. Diamond drill holes have extended the zone of known deposit for fully 3000 feet, and this method of prospecting has added to the depth shown by open work, showing the body to extend on its dip at least 1000 feet. Its limits have not been determined either on the dip or on the strike, and as exploration work progresses, the magnitude of the ore body is revealed. The diamond drill has also disclosed a second deposit or lens of ore about 100 feet deeper than the first. This ore body shows a marked advance in grade. It is estimated that fully 2,000,000 tons of ore are now available, and it has been stated that the Balaklala mine could be made to show several million tons of ore reserves at no great cost for development. A total of 3500 feet of cross-cuts and drifts constitutes the development work so far done. C. A. Malm, of No. 222 Bush Street, San Francisco, is president of the company.

Ohio Consolidated.—Patented claims in Sec. 12, T. 33 N., R. 6 W.; owned by Morton & Bliss, New York. No development.

Friday & Lowden Group.—The Friday & Lowden group consists of thirteen claims, located in Secs. 5 and 6, T. 33 N., R. 5 W., and also that portion of the N. W. $\frac{1}{4}$ of Sec. 5 and the N. $\frac{1}{2}$ of the S. W. $\frac{1}{4}$ of Sec. 5 not included in the mineral

locations. This part of the land is patented. This group of claims is the first encountered on the copper belt on the north side of Squaw Creek, and is directly east of the gold belt in which the Uncle Sam mine is located. The geological conditions, however, are similar to the conditions encountered in other parts of the copper territory. The mine is opened mainly by means of tunnels. A cross-cut tunnel driven on the northerly end of the group, on the Cleveland claim, is in 140 feet, and 70 feet of this opening is in ore. A second tunnel has been started 175 feet deeper, which is now in 70 feet from the surface. On the Wild Bear claim easterly from the main development a 70-foot tunnel discloses considerable ore, and a shorter tunnel 250 feet farther along the strike is also in ore. On the common end line of the Wild Bear and Comstock claims a tunnel 65 feet in length shows some sulphide, after penetrating the gossan or oxidized ore, the latter prospecting in free gold. The total tunnel openings aggregate fully 800 feet in length. The strike is northeast and southwest, and the croppings occur at an altitude of about 2000 feet. Messrs. Friday and Lowden, of Redding, owners.

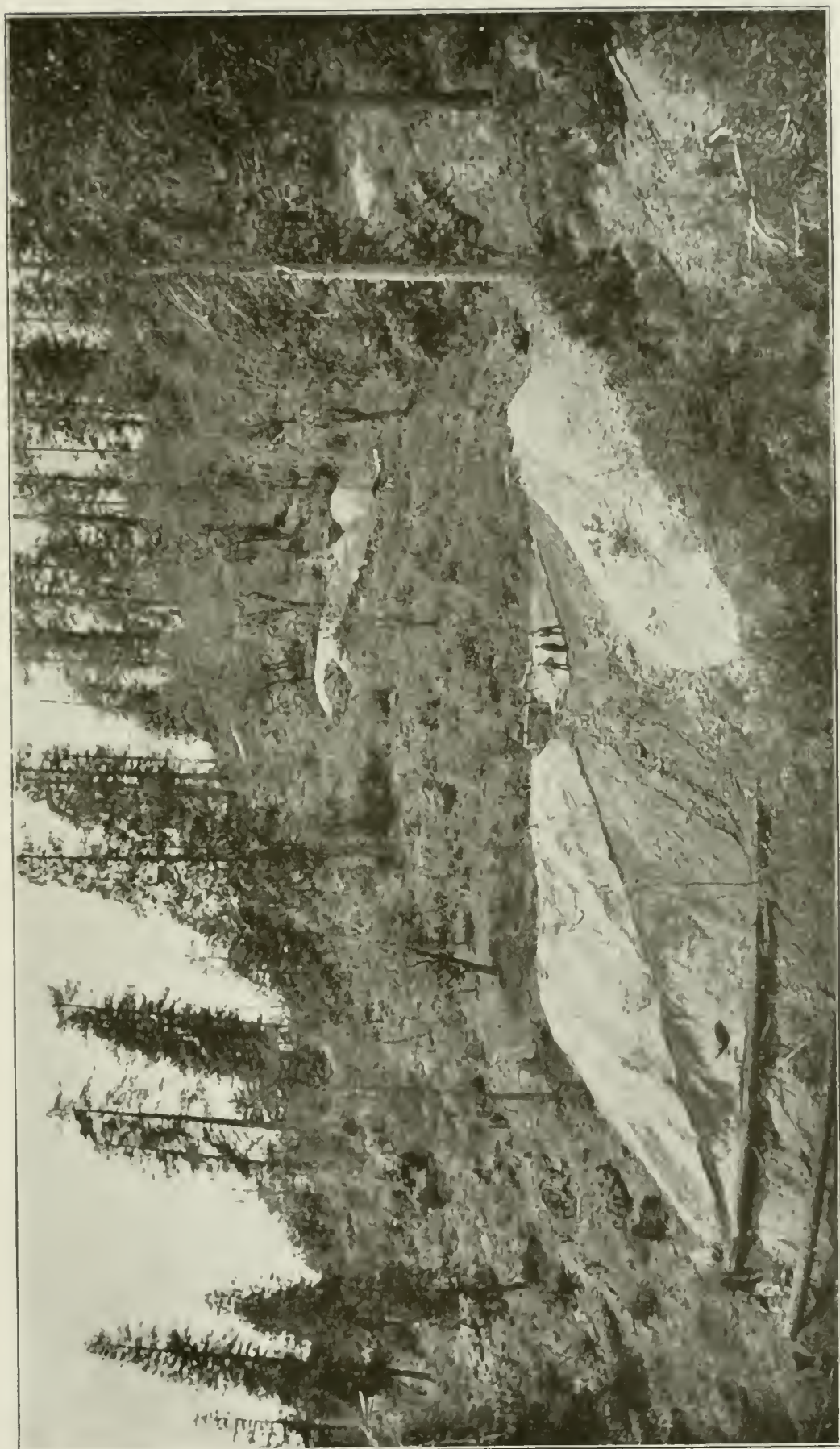
Mammoth Mine.—The Mammoth holdings include twelve claims and a patented section. The twelve claims are located in Sec. 32, T. 34 N., R. 5 W., and the patented section (29, same township and range) is located immediately to the north. This property is in the Backbone district, which at present constitutes the most northerly portion of the copper belt so far proved. It is about four miles northwest of Kennet and on the line of the Southern Pacific Railroad. The development up to the present has centered mainly on sections 32 and 16. Different tunnels of varying length have been driven. Some of these have reached ore and work on lower levels is now in progress. These tunnels aggregate 1400 feet. The main development of ore is at a depth of 75 feet, and a winze sunk from this level to a depth of 62 feet is in ore all the way. A tunnel is now being driven to cut the ore body 15 feet lower than the bottom of the winze. Drifts on the main level disclose a large amount of ore to that depth. A width of about 80 feet is shown and the ore body has been developed 190 feet on its strike. Explorations on a large scale have recently been started on section 29 about a half mile from the main developed

portion of the ground. The outcrop here indicates a large body of ore, the gossan showing a width of 200 feet and a length of 800 feet. A force of about 25 men is at present employed. The ground is being developed under the direction of John Fillins, by a Boston exploration company. R. M. Saeltzer et al., of Redding, owners.

Mayflower.—Six unpatented claims in Sec. 32, T. 34 N., R. 5 W.; owned by C. G. Ferguson and B. Golinsky, of Kennet. A little development work has shown some high-grade ore.

Bohematosh.—Seven claims in Sec. 25, T. 33 N., R. 6 W.; owned by Walter Friday and J. R. Lowden. Disseminated sulphides are abundant, with extensive croppings of gossan. This is several miles north of the definite limits of the belt proper.

Summit Group.—The Summit group of mines is located on Behamatosh Mountain at the head of Little Backbone Creek, in Sec. 30, T. 34 N., R. 5 W., at an altitude of about 3000 feet. It immediately adjoins the Mammoth holdings and consists of eight claims, lying on the ridge between the north and south forks of Little Backbone Creek on the easterly slope of the mountain. The ground is very regular, the formation being the same in character as the more southerly parts of the belt. The country rock is heavily mineralized and the surface indications are very pronounced in this part of the belt. The strike of the ore body can be readily traced around the mountain side for fully 2400 feet. Two tunnels have been driven, one on the northeasterly and the other on the southerly portion of the ground about 1600 feet apart. Tunnel No. 1 is in 140 feet and has reached ore at a depth of 80 or 90 feet. Prospect shafts sunk on the croppings above the face of this tunnel indicate a width of at least 35 feet. At a depth of 20 feet in the shaft, ore reported to assay 8 per cent was encountered, and the sulphide ores encountered in the tunnel below this shaft show values reported at from 6 to 14½ per cent copper. The first 90 feet of Tunnel No. 1 was driven through a secondary deposition caused by leaching of the ore body. This carried some value throughout. The next 50 feet passed through a quartzite foot wall intersected by numerous seams bearing sulphide ore varying from a few inches to a foot and a half in width. Between the foot wall and the solid sulphide body a



ORE DUMP AND TUNNEL, MAMMOTH COPPER MINE, SHASTA COUNTY

breccia carrying a high percentage of copper sulphide was encountered. Tunnel No. 2, 1600 feet to the southwest, is in 75 feet, but has not yet reached the ore as exposed by the prospect shaft on the line of outcrop. Native copper is found in the seams formed in the foot wall. The Summit mine is being developed under bond by the Mount Shasta Gold Mines Corporation of Chicago; Frank E. Ware, general manager; M. E. Dittmar et al., of Redding, owners.

Ferguson & Limbough.—This group, in Sec. 4, T. 33 N., R. 5 W., is developed by 165 feet of tunnels showing some ore.

Great Verde.—Eleven claims in Secs. 11 and 12, T. 33 N., R. 6 W.; owned by John R. Lisle et al., of Redding. Two hundred feet of tunnels open into an ore body of undetermined extent. The gossan outcrop is 60 to 80 feet wide.

Graves Group.—Immediately to the south of the Summit group is located the Graves group of mines, owned by R. M. Saeltzer et al., of Redding. This property has been bonded by M. E. Dittmar and is included in the bond which the Mount Shasta Gold Mines Corporation holds on the Summit group. Development consists of assessment work, and at the present time all exploratory work is being concentrated on the Summit claims adjoining. M. E. Dittmar is superintendent.

Golinsky.—Twelve unpatented claims, located mainly in Sec. 28, T. 34 N., R. 5 W.; owned by B. Golinsky, of Kennet. About 750 feet of openings show ore of some value. The principal known shoot is said to have a width of 30 feet.

Keystone.—Six unpatented claims in Sec. 23, T. 33 N., R. 6 W., north of the belt proper. Only assessment work has been done. Owners, Charles Butler et al.

The foregoing properties are those worthy of present note on the west side of the Sacramento River, and embrace the groups of claims ranged for about twelve miles along the western end of the belt northeasterly from Iron Mountain. On the east side of the Sacramento River the belt includes the following properties:

Gregory & Whalen.—Also known as the Oom Paul group. Undeveloped claims showing gossan croppings 30 to 40 feet wide, situated on the Sacramento River, a few miles north of Kennet, in Sec. 25, T. 35 N., R. 5 W. Small development.



OOM PAUL CLAIMS, GOSSAN CROPPINGS, SIESTA COUNTY

Shasta May Blossom Group.—Known as the Keith group. This property comprises eight claims in Sec. 14, T. 34 N., R. 3 W. The development work is mostly superficial, and made to determine where the ore body lies. There are several open cuts and short tunnels. The present development consists of three tunnels, besides some open cuts. The lower tunnel is in about 70 feet, and follows the ore body, which is a low-grade iron sulphide carrying very little copper. The vein matter is a spar. The east or foot wall is a gray schistose rock; the west, or hanging, is a gray porphyry. The ore channel is about 50 feet wide. The next higher tunnel starts on the lower end of the Copper King claim, and runs to the northwest 90 feet through the wall rock. Its face shows decomposed ore material of little value. Twenty feet of it is in the ore channel. The ore is decomposed, and carries some gold. Higher up the hillside there is a body of gossan croppings, probably 70 feet wide. A new tunnel to get under these croppings has been commenced, but has not yet reached the ore channel. The croppings on top of the hill near the north end of the gossan croppings are of the same character as the west wall of Bully Hill, meta-rhyolitic porphyry. The top of the mountain is capped with the rhyolite. Below it, and dipping to the east, are the gossans.

Brushy Canyon Group.—Consisting of a number of claims, not patented, located in Sec. 34, T. 34 N., R. 3 W., and is owned by E. L. Blowers, James Drennan, and others. The group is under bond by the Bully Hill Company, and a small force of men is employed. The claims are developed by a few cuts, tunnels, and a shaft 80 feet deep. A large body of limonite ore (gossan) has been proved, but comparatively little sulphide.

Doedollis Group.—Consists of five unpatented claims located in Sec. 34, T. 34 N., R. 3 W., and is owned by William Ellis, J. L. Cannon, and others. Comparatively little work done at present.

Afterthought.—Consists essentially of four claims, only two of which are patented, all located in Sec. 11, T. 33 N., R. 2 W. It is owned by the Afterthought Mining Company. It has been recently worked under a bond by the Tarbet Syndicate. The development of the mine consists of seven tunnels, aggregating nearly 2000 feet, and a shaft 250 feet deep.

A large body of sulphide ore has been proved by this work, some of which is high in its percentage of copper, though mostly of lower grade.

Donkey Mine.—Consists of one patented claim in Sec. 11, T. 33 N., R. 2 W.; owned by the Tehama Mining Company, of Red Bluff, C. J. Gooch president. This mine has not been worked for many years, but has been developed by a shaft 200 feet deep and considerable drifting. There is in sight a good body of ore of good grade, carrying some blende. It is thought to be a continuation of the Afterthought.

Schmidt's Claim.—One claim near the Kosk Creek group; owned by Charles Schmidt. Some work has been done, showing sulphide ore. The vein is said to be 10 feet in width.

Chattadown Group.—Consists of an uncertain number of claims situated near the headwaters of Chattadown Creek, some twenty miles north of Baird, east of the McCloud River; owned by Edward Sweeney, Reed Bemis, and others. Some showing of gossan on surface and some work done showing sulphides, etc.

Kosk Creek Group.—Consists of twelve claims situated in Sec. 23, T. 37 N., R. 1 W., a number of miles north of the copper belt; owned by William M. Murray, R. M. Saeltzer, and others. Only little developed. Bonded by W. G. Scott and associates of San Francisco. This group is especially interesting, from the fact that the ore is a dark basaltic rock carrying native copper. The copper occurs in globules and films in the joints and vesicles of the rock. The ore is said to carry some gold. The zone of rock carrying copper is said to have a width of 200 feet. Native metal occurs only near the surface; with greater depth, sulphides are found.

Hartford Group.—Consists of ten claims, three miles north of the mouth of Protem Creek, Shasta County; owned by the Hartford Consolidated Mining Company, Wm. Geary president and J. B. Giffen secretary. More than 400 feet of tunnels have been completed, proving some good sulphide ore, but at present only in limited quantity. The lode is said to have a width of 8 feet or more, and to appear along the surface for a distance of more than 100 feet. The surface ores are oxides and carbonates.

Cowboy Group.—Consists of three claims in Sec. 4, T. 33 N., R. 2 W.; owned by H. A. Cook et al., San Francisco. This property has good surface indications. Over 200 feet of tunnels have been completed, and good sulphide ore has been found. The property includes, in addition to the claims above mentioned, 160 acres of land in section 9 of the same township.

Black Diamond Group.—The Black Diamond group, consisting of a half section of land and eighteen claims located in Secs. 2 and 3, T. 33 N., R. 4 W., in the Stillwater mining district, is the property of the Northern California Investment Company. A great deal of development work has been done, but the ore so far reached has been low grade in character and the ground is as yet in a practically undeveloped condition. A body of ore of a reported value of 8 per cent copper was encountered several months ago, but since that time development has been discontinued and the value of the strike remains undetermined. In addition to the Black Diamond holdings, the company holds between 4000 and 5000 acres of patented land located in the Bully Hill region and in the district to the southeast. George Bayha, the vice-president of the company, is in charge of the property. The company expects to commence exploratory work on a more extensive scale in the near future in order to determine the value of its holdings.

Roseman Group.—The Roseman group consists of nine claims and a smelter site, located in Sec. 3, T. 33 N., and Sec. 34, T. 34 N., R. 4 W. The ore is a carbonate and oxide near the surface, changing to sulphide with depth. The formation has nothing in common with either the West Side district or that of Bully Hill. The ore occurs in or near the lime deposit, the foot wall apparently being in serpentine. The development is mainly along the outcrop and the greatest depth on the vein attains about 60 feet. The main cross-cut from the foot wall toward the hanging wall is in 55 feet. At another point a 40-foot cross-cut has been driven toward the hanging wall, but neither opening has disclosed the vein as yet. The vein matter through which these openings extend is well mineralized. In the aggregate 700 feet of tunnel and 200 feet of shafts and winzes constitute the development work.

A lower cross-cut has been started which will provide 400 feet of depth. The objective point is 600 feet in, and of this 120 feet has been completed. H. Roseman et al., of Redding, owners.

Jaegel.—Consists of seven claims in Sec. 3, T. 33 N., R. 4 W.; owned by Joseph Jaegel. Only a small amount of development work has yet been done.

Memorial.—Eleven claims of unpatented ground in Secs. 15 and 22, T. 33 N., R. 4 W.; owned chiefly by H. M. LeBaron and others, of Redding. A small force of men has been employed prospecting this ground, and some sulphide ore has been found.

Michigan Group.—The Michigan group of mines, consisting of six claims adjoining the Recorder claim of the McClure group on the south and west and De La Mar's property on the west, was recently acquired by the Mount Shasta Gold Mines Corporation, and will now be developed with the McClure group. This ground is located mainly on the south and west slopes of Bully Hill and is crossed by one of the Bully Hill lodes. The principal outcrop of the Bully Hill lodes is on the common end line of the Recorder and the Ydalpom claims, the latter being one of the claims that form the Michigan group. The development work consists chiefly of tunnels and drifts. Some very high-grade ore has been encountered in the workings, but the explorations have as yet not reached a point under the main croppings. A shaft sunk on the North Star claim disclosed some very good sulphide ore. The Mount Shasta Gold Mines Corporation recently acquired an option on 80 acres of land adjoining the Bully Hill smelter site, which will probably be used as a site for the proposed reduction works in the Bully Hill district. W. F. Russell is in charge of developments.

Northern Light.—One claim, unpatented, in Sec. 21, T. 34 N., R. 3 W.; owned by the Bully Hill Company. Considerable development work has been done on this ground, and good bodies of sulphide ores similar in character to other deposits in this district have been discovered.

Excelsior.—A group of five claims, two of which are patented, located in Secs. 21 and 28, T. 34 N., R. 3 W.; owned

by the Bully Hill Gold Mining and Smelting Company. A considerable force of men was employed in development work upon the Excelsior, South Killinger, and Baxter claims, including what are known as the Baxter and Winthrop tunnels. The lowest tunnel is the Winthrop, which has been driven for a distance of 850 feet, and it is expected that it will cross-cut the Baxter-Excelsior ore bodies. In the Excelsior tunnels a body of solid sulphide ore has been exposed, more than 20 feet in thickness, but probably high in its percentage of zinc.

Arps.—Fifteen claims, in Secs. 20, 21, 28, and 29, T. 34 N., R. 3 W.; owned by William Arps, R. M. Saeltzer, and others, of Redding. This property is now being developed under bond by H. M. Hall. Good sulphide ores have been found in numerous places. Four tunnels aggregate 1600 feet.

McClure, or Pioneer, Group.—This property is located principally in Sec. 16, T. 34 N., R. 3 W., and adjoins the De La Mar mine on the northeast. It includes a quarter-section of patented land and six claims. The most important claim, the Recorder, lies on Bully Hill immediately adjoining the De La Mar holdings, and is on the strike of the De La Mar lode. The development work on several levels of De La Mar's Bully Hill mines has been carried practically to the Recorder claim. The principal development work on the Recorder claim consists of a cross-cut tunnel, which was started by the pioneer owner of the property, H. C. McClure, and this tunnel has been continued by the Mount Shasta Gold Mines Corporation, which is now developing the mine. Ore has been reached in this tunnel. The ore, like that of its famous neighbor, is high grade and carries good values in gold, silver, and copper. Where the outcrop crosses the McClure ground, recent explorations have disclosed a lode of great width, and from present indications a second property of magnitude on Bully Hill is a certainty.

Ydalpom.—Consists of two unpatented claims in Sec. 16, T. 34 N., R. 3 W.; owned by T. M. Popejoy and others, of Copper City. These claims are now under bond by the Bully Hill Company, and development work is in progress, with good ore bodies proved.

COAST RANGE DEPOSITS

The Coast Range of California presents a copper field of very large area, but one that, through lack of exploration, development, and production, is of minor present importance compared with the copper belts of Shasta County and the Sierra Nevada foothills. The Coast Range (properly the Coast Ranges) of California consists of a group, or series, of ranges stretching for over 500 miles southward from Oregon along the coast of the State and having an average width of about 40 miles. Topographically, the Coast Range is relatively low, is made up of ranges of diverse trend, and it incloses numerous valleys, the most important ones being those in the general region of San Francisco Bay, which are among the famed garden spots of California. Lying near the coast, with the broadest general slope toward the sea, and with a comparatively low elevation (2000 to 6000 feet), the range possesses a mild climate and receives on the direct Pacific watershed a copious rainfall which bestows an abundant water-supply and heavy forest growths. The Coast Range merges with the Sierra Nevada in Northern California and in the Tehachapi region at the south.

The copper deposits, as well as those of other economic minerals, are found scattered over the length and breadth of the range. They are much more numerous and generally of larger magnitude north of the Bay of San Francisco and they are of greatest number and importance in the large northern region comprising Siskiyou, Del Norte, and Trinity counties, which require main attention in connection with the copper, as well as the gold, resources of the Coast Range.

Where the Sacramento Valley wedges its narrow northern end into the broad mountain mass created by the mergence of the Sierra Nevada and Coast ranges is found the Shasta County copper belt. Because of the individuality of this belt, and its overshadowing importance as a copper producer, Shasta County is in this work set apart from the copper regions adjoining it on the east, north, and west, though geographically and topo-

graphically it belongs with Siskiyou County to the north. All other copper deposits in north-central California are here grouped as of the Coast Range.

To gain a brief general view of this wide northern copper field, we may go northward from the Shasta County copper belt along the Sacramento River cañon and the railroad line to Oregon for thirty miles to the southern boundary of Siskiyou County, finding but few scattered copper occurrences through all this upper portion of Shasta County. Pursuing this course northward, there is encountered in southern Siskiyou County, near the western flank of Mount Shasta, a series of copper deposits ranged along a belt or zone several miles wide, extending for about fifty miles northward to the State boundary along the central line of the county. The majority of the deposits of Siskiyou County noted in this bulletin are in this belt, in townships 6, 7, and 8 west and 40 to 46 north, but they are most numerous in the south central portion, within a few miles of Mount Shasta. This belt is just west of the great blanketing lava sheet of northeastern California and about seventy miles from the coast. Practically connecting with the northern end of the belt described is another series of copper deposits stretching for sixty miles or so along the Siskiyou range and Klamath River, which course westward along the State boundary into Del Norte County. These series of deposits constitute copper belts in only the broadest meaning of the term, being unconnected occurrences geographically arranged in this manner. In these two belts are the chief known copper deposits of Siskiyou County, though copper is found widely scattered in mineral-bearing districts over the western half of the county. To the west of Siskiyou, Del Norte County, in the northwestern corner of the State, presents a promising copper field. The Low Divide district, about fifteen miles northeast of Crescent City on the coast, and near the State line, is the best known district, and one in which a number of mines were actively worked nearly forty years ago. Other districts in the southern and eastern parts of the county have since become prominent for their copper prospects.

The region comprising these two counties, over which copper belts or districts, and sporadic occurrences, are thus scattered, is, roughly, over 100 miles long and 50 to 60 miles wide. Viewing the principal deposits of the Coast Range farther southward

they may be conceived as forming the stem of a great, rude letter T. They lead southward from southeastern Del Norte and southwestern Siskiyou along a belt nearly 100 miles long, which follows the boundary line between Humboldt and Trinity counties, through the heart of the range and its remote wilderness. A few groups of deposits are found in eastern Humboldt County, but they mainly lie in the two tiers of townships which stretch the length of western Trinity County. The outlines of this big letter T, with a bar 50 by 100 miles in size, and with a stem 100 miles long and perhaps 20 miles wide, may, to aid memory and understanding, be regarded as practically inclosing the copper deposits of the northern portion of the Coast Range and the important copper field of the coast region. The Shasta County copper belt lies about 50 miles east of the center of the stem and directly south of the eastern end of the bar.

This cupriferous T lies in an undeveloped mineral empire rich in gold, filled with mountain streams and untouched forests, and before it is opening a great future, in which the mining industry will hold the leading place. Access to these stores of copper is gained from the railroad to their east, or from the two harbors of Eureka and Crescent City to the west, but from neither side do railways yet reach into these rugged and forested fastnesses, and main highways are few. Only mountain trails lead into some of the regions where copper claims are held and slowly opened at the surface. Plans for a railroad from Eureka across Trinity County to Redding and on to eastern connections are now attracting attention. The Coast Range runs northward into Oregon, and the copper region described also extends into the southwestern part of that State.

The portion of the Coast Range thus described differs geologically from the rest of the range to the southward, and so, to a considerable degree, do the copper deposits. Here, as to the south, the ore bodies occur in veins in igneous or metamorphic formations. In both regions serpentine and diorite are the characteristic inclosing rocks, and the former especially accompanies them, forming one or both walls. Only in Del Norte County has there been more than superficial prospecting of any of the deposits of this northern region. Quite a number of mines in this county shipped ore in the first half of the decade of the sixties, and at least two were opened to depths of

about 400 feet. These developments showed the ore bodies, which were frequently rich, to be irregular bunches of limited extent, as a rule, and not in well-defined lodes. Surface indications and the slight developments that have been made in Siskiyou, Trinity, and eastern Humboldt make it probable that there the deposits will be found more regular and persistent. Wide gossan croppings can, in places, be followed for several miles, but prospect tunnels have yet been run under these croppings in but relatively few cases. The ensuing notes on some of these prospects show that in Siskiyou County and elsewhere tunnels have reached ore bodies from a few feet to forty or more feet wide and carrying good values in copper, with varying percentages in the precious metals. One undeveloped prospect in the remote southwestern corner of Trinity County has become noted for the immense boulders of sulphide ore, carrying gold, silver, and copper, which have come from an outcropping deposit, one of these boulders being sixty feet across the base and consisting of several thousand tons of solid ore. Large and valuable deposits will undoubtedly be developed in the future. The copper ores of these northern counties are practically all sulphides. Surface oxides and carbonates do not occur as frequently and extensively as throughout the rest of the range to the southward.

Southward from Trinity County for about 150 miles to the bay of San Francisco, copper deposits are heterogeneously scattered over the ranges through the western ends of Tehama, Glenn, and Colusa counties, through Mendocino and Lake counties to the west, and through portions of Sonoma, Napa, and Marin counties just north of the bay. The majority of the deposits through this large region are associated with serpentine formations, and the prevalent ores are oxides and carbonates. The ores are generally in pockets, and carry but slight values in gold and silver. Native copper occurs as float in several districts, but assumes no practical importance. The only copper belt presented by this large portion of the range is one 60 miles long, running along the eastern slope, near the range summit, from Tehama County southward through Glenn and Colusa to a termination in Lake County. This is a mineralized zone, along which copper deposits have been discovered at intervals and many have been superficially opened

by shafts and tunnels. One of the small early attempts at copper smelting was made on this belt, and a few tons of ore have been shipped; but, as elsewhere through this portion of the range, no copper deposits of much importance have been discovered and no successful mining has ever been carried on. West and south of this belt are many sporadic occurrences in the counties named, and a considerable number have been prospected to a limited extent at various times, chiefly during the copper excitement of the early sixties and within the past two or three years. The deposits of this portion of the range are more advantageously situated in respect to convenience of access than those of the north. Copper mining in these counties has amounted to little more than gophering after stringers and pockets of ore, often rich in quality but small in quantity.

For a distance of about 200 miles southward from the region of San Francisco to San Luis Obispo County, copper minerals have been noted in every county of the range, but the occurrences are sparse and of slight significance. In the region of Mount Diablo, in Contra Costa County, many thousands of dollars were spent between 1860 and 1866, by several companies, in prospecting for copper, of which there were surface indications in the form of float, but no deposits were ever found in place. Close to Oakland, in Alameda County, a recently discovered lode carrying copper and iron pyrites is being mined to supply sulphur for acid manufacture. Many years ago some copper ore was shipped from a deposit in San Benito County. The only copper district worthy of particular attention, between San Francisco Bay and the Tehachapi region at the southern end of the Coast Range, is one in San Luis Obispo County. Here is a belt of cupriferous ores extending for perhaps 20 miles through the mountains between the town of San Luis Obispo and the old mission of Santa Margarita. During the first period of copper mining in California a great many claims were staked out and considerable ore was shipped from several mines of small development. Recently renewed attention has been given to some of these properties. Near Soledad Pass, in the general region of the mergence of the Coast and Sierra Nevada ranges at the south, there is a copper district which afforded the first copper ores ever mined in California, and which was a lively copper mining camp for a short time in early days.

Throughout the Coast Range there has been no production of copper since the small ore shipments of former times. Many new and old locations have been prospected recently. The northern counties promise important future developments, and throughout the range various properties will probably become small producers in time.

SISKIYOU COUNTY.

Siskiyou County lies along the northern boundary of California, one half the length of which it measures, and has adjoining it Del Norte on the west, Modoc on the east, and Shasta and Trinity counties on the south. Its entire area of 3040 square miles is an exceedingly broken and picturesque expanse of mountains, cañons, and wilderness, threaded by a multitude of streams running southward to the Sacramento and northerly and westerly to the Klamath River, which courses for 70 miles through the county.

The most prominent mountain ranges are the Klamath, Scott, and Salmon. Mount Shasta, in the southern part, raises its whitened volcanic peak 14,450 feet above the sea. The eastern third of the county, comprising thirty-four townships, is blanketed by a portion of the great Sierra Nevada lava sheet, forbidding both mining and agriculture. The rest of the county displays much mineral wealth, mainly concentrated in various belts and districts. There are but two agricultural valleys of importance, the Scott and Shasta, the former 40 miles long by 6 miles wide. There is a multitude of springs, and some important mineral springs are well known.

Its mineral resources constitute the basis of Siskiyou's prosperity and progress. Its auriferous gravels still provide the bulk of the county's gold output, though the period of simple placer mining passed long ago. Along the Klamath and important tributaries large gravel deposits support profitable hydraulic mines and afford abundant opportunities for their multiplication. River-bed mining, by the use of wingdams, has been pursued more extensively than in any other county. Now gold dredging has become firmly established and prom-

ises to expand. Here, as in other mining counties, the growth of the mining industry depends on the development of the quartz mines, and in this direction Siskiyou County is now making the greatest progress in its history. Successful gold quartz mines have been developed in the past, notably the Black Bear with a record of over \$2,500,000, but only within three or four years has prospecting for gold ores been general and active and investments of mining capital frequent. This development proceeds rapidly, in spite of the surviving lack of roads and trails to some of the rich but remote mining districts. The Southern Pacific railroad to Oregon crosses the county, with a branch to Yreka. Most of the county is yet public land, and the prospector has a wide and free field. Platinum, chrome, lead, coal, iron, and mineral waters are among the minerals occurring here. This is one of the few counties of the State making an annual mineral record exceeding \$1,000,000. Its output in 1900 was \$1,010,383, of which \$951,397 was in gold.

The copper mines and prospects of Siskiyou County are widely scattered over the central and northern portions of the county, and include some properties of considerable magnitude. Most of them are of comparatively recent development, few of them having found mention in the later reports of the State Mineralogist. In the central portions of the county the prospects are confined to a very few townships lying to the east of Scott Valley, in the vicinity of Fort Jones and on certain tributaries of the East Fork of Scott River. The formations in which these deposits occur are either peridotite or gabbro, or a metamorphic schist overlying these eruptives. The ores are largely sulphides of iron and copper, and include pyrite, pyrrhotite, and chalcopyrite. Some of the deposits that have been regarded as valuable for copper are chiefly interesting for their gold and silver values, and as a possible source of silicious ores for prospective operations.

The prospects found to the north of the Klamath River are scattered throughout the whole extent of the Siskiyou range from the vicinity of the Cottonwood Valley westward to Preston Peak. They may be grouped in five districts—the Cottonwood, Applegate, Indian Creek, Clear Creek, and Preston Peak districts.

The formations in which these deposits occur are various.

The Siskiyou range, like other east-and-west ranges in the Klamath region, is one of complex geological structure. In general terms it is composed largely of crystalline schists and slates and basic eruptive rocks which are involved in or underlie them. The basic rocks are mainly of the peridotite-diorite class. Granite also occurs at intervals throughout the range.

The basic crystalline (eruptive) rocks form some of the most prominent points of the range, no less conspicuous for their color than for their altitude. Several of the prominent mountains have been indiscriminately styled "Red Mountain," on account of the reddish-brown color which peridotite assumes in weathering. Preston Peak, Greyback, and others of the higher summits are of diorite or kindred rocks. While the main course of the range is westerly, its actual watershed is extremely devious, passing alternately into Oregon and into Northern California. Copper deposits are found either in slate, schist, diorite, gabbro, or serpentine.

The Siskiyou Mountain Copper Belt, if it may be so styled, follows approximately the Oregon and California state line for a distance of 60 miles, with a width of more than 20 miles from the Klamath River north into Oregon. As a mining region it has been prospected to a very small extent for either gold or copper. Yet it is interesting to remember that the streams heading in this range, both on the north and south, have been among the richest placer streams in this region. And it is also true that this range contains as clear evidences of copper deposits as of gold, and should be as attractive to prospectors in search of base metals as to those in search of any other. Although this region is exceptionally rugged in places, it is by no means unapproachable, particularly from the north. The natural advantages of water-power and timber are everywhere abundant.

The following groups of copper claims are those of most note that are at present known in Siskiyou County:

Hummer Group.—Consists of three claims in Sec. 18, T. 40 N., R. 7 W., M. D. M.; owned by Messrs. Mischler & Rollins, of Callahans. These claims have been worked to only a limited extent by shafts and open cuts. The formation is mainly serpentine, though the ore deposits are connected with dikes of quartz porphyry which have penetrated the serpentine. The ore lies in irregular bodies, consisting of pyrrhotite and

other sulphides carrying copper. The ore is said to contain nickel. Development work was in progress.

Bonanza Group.—Twelve claims in one body situated in Secs. 27 and 34, T. 42 N., R. 8 W.; owned by Charles S. Cowan, of Fort Jones, W. S. Carrico, and others. Developed by shafts and tunnels; work in progress. These deposits are in the form of quartz veins carrying a small percentage of sulphides, but are chiefly interesting for their gold and silver values.

Copper Queen Claim.—One claim in Sec. 27, T. 46 N., R. 9 W.; owned by H. J. Barton, of Oak Bar, and William Moxey; developed by tunnels 300 feet in length. The deposit is a quartz vein carrying sulphurets of iron and copper. Idle.

Plutus Group.—Five claims situated in Secs. 12 and 14, T. 40 N., R. 8 W.; owned by McCarter and John Erickson, of Callahans. Developed to a limited extent. The ore is pyrrhotite, with a small percentage of copper. The formation is gabbro and serpentine. Developing.

Fortuna Group.—Two claims in Sec. 14, T. 40 N., R. 8 W.; owned by E. G. Harrison of Callahans, and others. Developed by a shaft 40 feet deep. The ore is pyrrhotite, etc., in gabbro and diorite. Developing.

Solomon.—One claim in Sec. 14, T. 40 N., R. 8 W.; owned by M. Greenberg of San Francisco, and developed by one shaft 15 feet in depth.

Hidden Treasure.—Three claims, located on Boulder Creek, four miles southwest of Callahans; owned by John Russel and the Alger Brothers of Callahans. The vein is said to have a width of 8 feet, consisting of sulphide with some quartz. It carries copper, with some gold and silver. On the property there is one tunnel 100 feet long. Developing.

August Flower Group.—Two claims in Sec. 1, T. 41 N., R. 8 W.; owned by Harrison Bros., of Callahans. Developed to only a small extent. The ore consists of irregular bodies of pyrrhotite and chalcopyrite in serpentine. Developing.

Huntley Claim.—One claim situated in Sec. 12, T. 40 N., R. 8 W.; owned by Harry Mitchell, William Bremer, et al., of Callahans; 100 feet of tunnels completed and a shaft 22 feet

deep. The ore consists of pyrrhotite and chalcopyrite. Developing.

Lytle.—Two claims in Sec. 20, T. 40 N., R. 7 W.; owned by J. A. Lytle & Son, of Callahans. Developed by 300 feet of tunneling. The ore, which consists of irregular bodies of chalcopyrite and pyrrhotite, follows a contact between a dike of quartz porphyry and serpentine. Some of the lenses of ore have a thickness of 10 to 15 feet. The ore also contains some gold. Developing.

Polar Bear Claim.—One claim in Sec. 12, T. 40 N., R. 8 W.; owned by G. Welker & Sons, of Callahans, and others. Developed by a shaft 40 feet deep and tunnels 70 feet in length. The principal ore body consists of a shoot 5 to 6 feet wide, from which nearly 200 tons of ore were extracted in 1900, carrying values reported at about 17 per cent of copper. The ore is chalcopyrite and pyrrhotite in serpentine. Developing.

Rader Group.—Three claims in Sec. 17, T. 40 N., R. 7 W.; owned by Charles Rader, of Gazelle, and others. Some development work has been done. The ore consists of pyrrhotite, and is said to contain nickel. Developing.

Turner Claim.—One claim in Sec. 7, T. 40 N., R. 7 W. Some work has been done, with a good showing of chalcopyrite. Developing.

Monarch Copper Group.—Consists of about 240 acres of patented land situated in the east half of Sec. 7, T. 40 N., R. 7 W.; owned by the Monarch Copper Mining Company, Charles F. Pettey, of Callahans, president. Developed by about 200 feet of tunnels and a shaft 20 feet and one 30 feet deep. Sulphide ores of good grade are reported. Developing.

Thanksgiving Group.—Consists of several claims one and a half miles northeast of Oro Fino; owned by George Henderson, of Fort Jones. Small development. Surface indications very good.

Rothkoph Group.—Fifteen claims located in Secs. 5, 6, 7, and 8, T. 43 N., R. 8 W., four miles northeast of Fort Jones; owned by George Henderson, of Fort Jones. Developed by shafts and tunnels with a total length of 350 feet. The formations are basic eruptive rocks, including serpentine overlaid by silicious strata containing some slate. The ore

lies partly along the contact, and consists of chalcopyrite and pyrite in lenticular bodies, having a width of 5 or 6 feet. Several patches of gossan and iron-stained rock occur on the surface. Some of the ore carries values reported at 12 to 15 per cent copper.

Schnider Claims.—Two claims in Sec. 12, T. 40 N., R. 8 W., and Sec. 18, T. 40 N., R. 7 W. Developed to a small extent by open cuts. The ore is similar to that of the Polar Bear. Owned by L. Schnider & Son, of Callahans.

Rainbow Group.—Fourteen claims in T. 40 N., R. 5 W., four miles southwest of Sisson; owned by the Mount Eddy Mining and Development Company, of San Francisco. Gossan croppings, 100 to 600 feet wide, are exposed for over a mile on a spur of Mount Eddy. The nearly vertical ledge is cross-cut by deep cañons, from one of which a short prospecting tunnel has been run. Copper minerals are shown, but the value of the property is indicated only by surface exposures.

Yellow Buttes Group.—Three claims situated about fifteen miles southeast of Montague, on the north slope of Mount Shasta. Owned by Harvey Sorter, of Montague, and the Dennis Brothers. This property is but little developed at present. The formations are schist and granitic rock, between which the vein extends in a north and south direction, having a width of 4 or 5 feet. The ores are chalcopyrite and the carbonates of copper in a gangue of quartz.

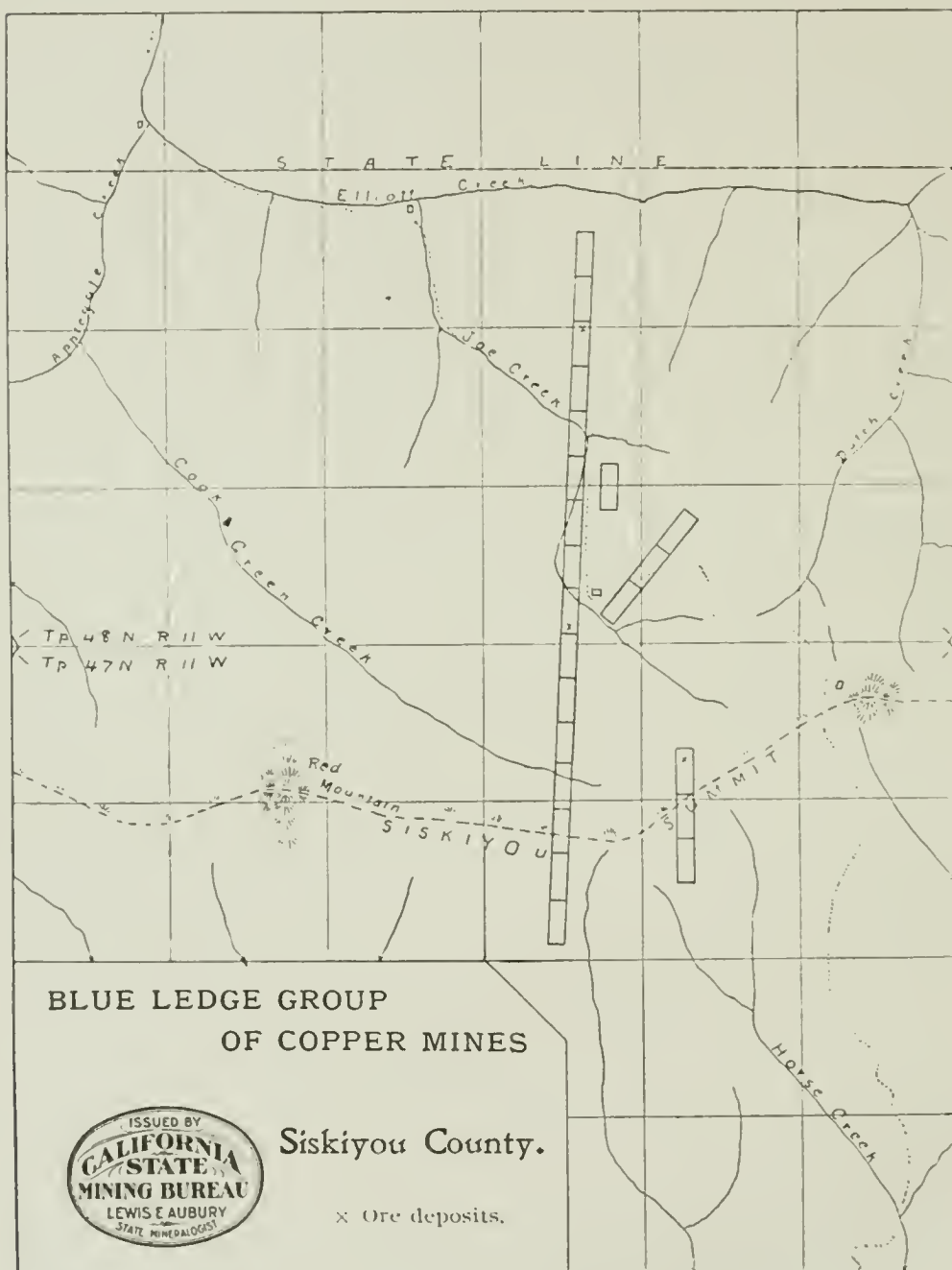
Bonanza Group.—Two claims in T. 47 N., R. 8 W., M. D. M.; owned by Erick Carlson, of Hornbrook, and others. The property is developed by 520 feet of tunnels, shafts, etc., showing a deposit of sulphide ore 8 to 12 feet thick, which has been followed laterally for a distance of 100 feet. The ores are pyrrhotite and chalcopyrite, some of which carry a good percentage of copper. Assays have shown reported values ranging from 8 to 20 per cent copper.

Bunnell Group.—Comprises a number of claims situated near the head of Dutch Creek, adjoining the Bonanza group, and containing similar ores. They are owned by the Bunnell Brothers, of Gottville. They have been developed but little.

Unexpected Group.—Two claims in Sec. 17, T. 47 N., R. 8 W.; owned by Ponnay Brothers et al., of Portland, Or. These claims join the Bonanza and Bunnell groups, and con-

tain ores of the same character. They are at present developed only by short tunnels and open cuts.

The deposits of the three preceding groups are mainly contained in a crystalline (hornblendic) schist, associated with peridotite.



Blue Ledge Group.—Twenty-three claims, owned by L. F. Cooper, Wm. H. Hamilton, and others, of Crescent City. The property is developed by over 200 feet of tunnels and some open cuts. The formation is a crystalline schist, silicious and

chloritic in character, with a steep inclination to the west. It is associated with basic eruptive rocks. A large body of sulphide ore has been struck upon this property, one tunnel having penetrated the solid ore for a distance of more than 100 feet, with cross-cuts showing a width of 40 feet or more. The ore bears pyrite, chalcopyrite, and other sulphides and oxides of iron and copper. It carries a small percentage of zinc blende and some quartz. The average value of the ore is reported above 6 per cent, while some assays have shown very high-grade results. Samples have shown a reported value in gold and silver of more than \$5 per ton. The apparent opportunities for finding other shoots of ore are good. This property forms one of the more important of the copper prospects of the Siskiyou Mountains.

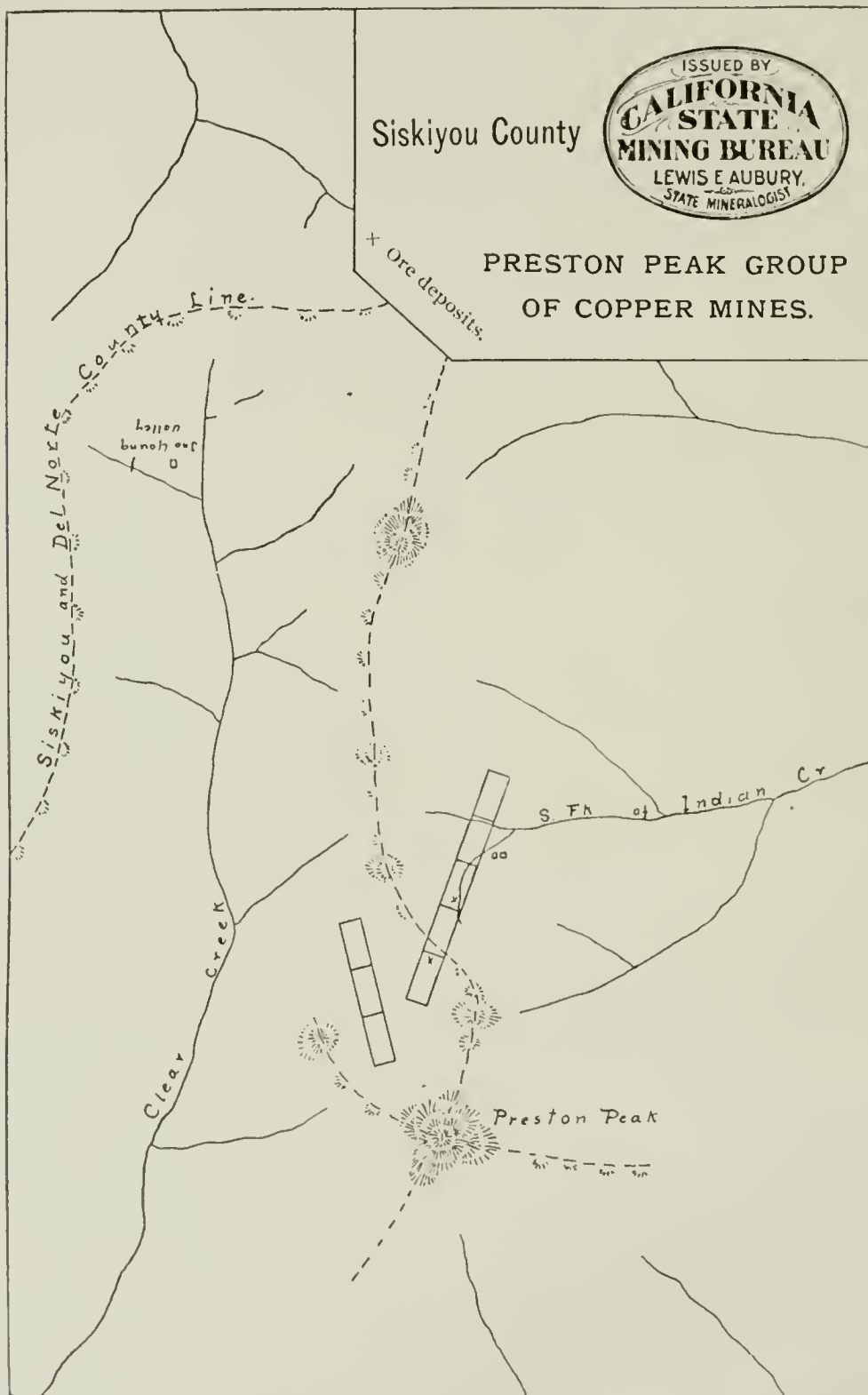
Nigger Creek Group.—Several claims owned by David Jones of Fort Jones, et al., situated near the head of Nigger Creek, five miles northwest of Hamburg Bar. Small development.

Clear Creek Group.—Five claims, situated on Clear Creek, eleven miles southwest of Happy Camp; owned by L. T. Hendricks and M. Thompson, of Happy Camp. The property is developed by a short tunnel. The deposit is said to have a width of 30 feet and appears at intervals for a distance of 2000 feet or more. The ore is a mixture of slate, quartz, and sulphides, the latter apparently of good grade.

Indian Creek Group.—Ten claims situated along the east side of Indian Creek, extending northward to five miles north of Happy Camp. Owned by J. Henry Wood, W. R. Brown, and the Hendrickson Brothers, of Happy Camp. Developed by tunnels aggregating about 475 feet. The formation is slate overlying peridotite at the north. The ores are pyrite and chalcopyrite interlaminated with slate, forming shoots of a mixed character 20 to 40 feet in thickness. Some very good ore has been found with gold and silver.

Klamath Group.—Three claims situated three miles east of Happy Camp; owned by J. H. Wood, W. J. Brown, Martin Cuddihy, et al. Seventy-five feet of tunnel has been completed, and ore found which is said to have a value of 12 per cent in copper.

Preston Peak Group.—Five claims situated at the head of the south fork of Indian Creek, one and a half miles north of



Preston Peak; owned by Preston Peak Copper Mining Company. Developed to some extent in past years. The formation is

mainly diorite or gabbro. The lode crosses the summit in a southwesterly direction, and consists of a succession of shoots, some of which have a width of 20 to 30 feet. The ores are pyrite and chalcopyrite. The average grade of the ore is said to be 12 per cent in copper, with some gold. This property is one of the pioneer discoveries of the Siskiyou belt.

DEL NORTE COUNTY.

Del Norte County commands a prominent place in any story of California's copper industry, on account of its historical associations with the beginning of that industry and because of the quite widespread occurrences of copper ores, their frequent richness, and the possibilities of future development.

It is one of the smaller counties of the State, is sparsely settled, and possesses well-wooded and mineralized mountains in the seclusion of the northwest corner of the State, far from railroads, and with the Pacific for its chief highway to the rest of the world. It is this remoteness which has been the principal hindrance to the development of its mineral resources, among which copper has ever held an important place. As is noted elsewhere, copper mining was active here in the sixties, and thousands of tons of high-grade ore were shipped to Swansea at a cost of about \$30 per ton, including costly haulage to the coast. That unfavorable economic condition, coupled with lower prices for copper and a partial exhaustion of rich surface ores, imposed a long quiescence on the industry. The copper revival has again quickened interest in Del Norte's oft-mentioned copper deposits, of which only superficial exploration has yet made anything known, and many old claims have been re-opened and prospecting has added many new discoveries. Many favorable conditions for copper mining exist, and sooner or later capital will undertake efficient exploitation by modern methods and production will be resumed. The larger part of the county's area is yet public land, and here the prospector finds a continuance of the wide and attractive field afforded in adjoining counties of Northern California.

Most of the known deposits of copper in this county lie along

its northern border, and for the most part are situated on some of the northern tributaries of Smith River. Three districts are now generally recognized along this belt, although good deposits occur outside of them in other sections of the county. The two older districts are those of the Low Divide and of Diamond Creek. The more recent discoveries have been made farther east, upon Shelly Creek, and one of the tributaries of the Siskiyou Fork of Smith River. In the southern portion of the county is the Doctor Rock group, which will be mentioned elsewhere.

The formation which composes the greater part of Del Norte County and that in which most of the copper deposits lie is peridotite (serpentine). Diorite or gabbro is generally found accompanying the peridotite, and they are generally regarded as more favorable to permanent deposits of ore. The cores, or central portions, of many of the ridges and spurs are of a gray crystalline rock, either gabbro or diorite. This is superficially covered by a thick casing of serpentine. The diorite or gabbro appears in the more prominent points of the mountain, protruding through the serpentine, or exposed by erosion in some of the deeper cañons. At the contact of the serpentine with the gabbro or diorite, or within the crystalline gray rocks themselves, have been found some of the better deposits of ore, not only in Del Norte County, but also in Siskiyou and Trinity counties.

Most of the copper deposits of this county, however, are either in the peridotite, or are more or less closely connected with it. In many cases the shoots of ore that have been developed in former years are limited in extent, few of them having been proven to contain more than a few hundred, or even a few tons of ore. They are generally irregular, or else consist of a series of bunches or lenses of ore arranged along a zone which is itself only vaguely definable. The ore is often of very high grade, consisting of copper glance, black and red oxides, carbonates, and native copper. Pyrrhotite is often found, and in some cases magnetic iron or chromite accompanies the ores of copper. Chalcopyrite is not common. Gold and silver are almost universally reported as accompanying the copper and correspondingly increasing its value. It is not unusual for shipments of ore to carry an average of 30 per cent,



and often reach 50 to 60 per cent in copper. The cost of shipping ore from Crescent City to San Francisco is approximately \$6 per ton. The transportation of ore from the mines to the landing varies in each case, but it has generally ranged between \$2.50 and \$10 per ton.

The following are some of the more important copper mines and claims in the various districts of Del Norte County:

LOW DIVIDE DISTRICT.

Alta Group.—Two patented claims, owned by the Bacon estate, San Francisco; not worked since 1865; located in Sec. 35, T. 18 N., R. 1 E., H. M.

Aurora Group.—Four claims two miles east of the Alta; owned by T. J. McNamara, of Crescent City, and others. The ore of this mine is reported to contain considerable gold in addition to the copper contents.

Copper Hill Group.—Four claims one-half mile east of the Alta mine; owned by the Low Divide Copper Mining Company. This group is believed to cover three distinct lodes, two of which have a northerly course. The ore is high-grade sulphides, oxides, and carbonates. John Murray, Crescent City, is president of the company.

Express Mine.—The claim is northeast of the Alta; Wm. Fleming, Crescent City, owner.

Mammoth Mine.—One patented claim in Sec. 26, T. 18 N., R. 1 E., H. M.; owned by the Tyson Company, of Baltimore, Md. The claim contains deposits of both chromic iron and copper ore. Both have been developed to some extent.

Occidental Group.—Five claims joining the Alta on the south; owned by the Low Divide Copper Mining Company.

Occidental No. 2.—The claim is located near Copper Hill; owned by J. A. Johnson, Crescent City.

Union Group.—Two claims joining the Alta on the north; owned by the Union Copper Mining Company.

DIAMOND CREEK DISTRICT.

Bear's Nest Group.—Eight claims on west side of the North Fork of Smith River, near the Oregon and California state line; owned by Isaac Dietrick, of Smith River, Malone Bros., McNamara et al. Developed by a long tunnel and open cuts; ore forming a lode 9 feet in thickness and consisting of pyrrhotite and other sulphides, with some gold and silver.

Five Diamonds Group.—Five claims, situated on Diamond Creek; owned by C. W. Baker, of Medford, Or., Harvey Colson et al.

Keystone Group.—Two claims situated on the North Fork of Smith River, near the State line; owned by Isaac Dietrick. Developed by short tunnels and open cuts. The formation is serpentine. The ores are copper glance, red and black oxides, carbonates, and native copper. Five tons of ore which was shipped to a reduction works had a reported value of 62 per cent of copper. Magnetic iron also appears in the claims.

McKee Claims.—Three or more claims situated near the mouth of Diamond Creek on the North Fork of Smith River; owned by Simon McKee, Smith River. Some development.

SHELLY CREEK DISTRICT.

Alameda Group.—Two claims on Shelly Creek, one-half mile west of station; owned by J. E. Hill & Son, Shelly Creek. Developed by short tunnels. Formation diorite. Ores are pyrite and chalcopyrite, with quartz and waste matter. Sulphide values reported at about 3 per cent in copper, but ore is said to carry considerable gold.

Call Group.—Two claims on east side of Shelly Creek, one-half mile east of station; owned by F. B. Edwards. Developed by tunnels and shafts aggregating 200 feet. The ore is pyrrhotite and chalcopyrite, forming irregular bodies in serpentine, and carrying some gold.

Eva Group.—Three claims on Pattrick Creek, one mile west of Anderson's station; owned by J. B. Hill, Shelly Creek, et al. Tunnel 12 feet long, with shafts and open cuts. Good sulphides occur in quartz. The lode is said to be 15 feet wide.

Prudential Group.—Six claims situated on Shelly Creek, one mile north of Shelly Creek station; owned by the Prudential Mining Company, H. S. Reed, Medford, Or., manager. Developed by a 25-foot tunnel and a shaft 106 feet deep, with cross-cuts on the lode. The ore lies in two bodies with north and south strike, dipping east 30 degrees. The upper vein has a thickness of 25 feet, the lower one being still thicker. The ore is sulphide of iron carrying small percentages of copper and zinc. The chief values are in the gold content. The lode has been traced for more than 1000 feet on the surface.

Tuesday Morning Group.—Eleven claims, one and a half miles southwest of station on Shelly Creek; owned by J. E. Hill & Son. But little developed; carries some good ore, consisting of pyrite and chalcopyrite, with some gold.

OTHER DISTRICTS.

Del Norte Group.—Two claims one mile north of Adams Station, Smith River; owned by Mary Adams. Small development, but good ore found, consisting of sulphides with some magnetic iron.

Doctor Rock Group.—Five or more claims situated near the head of Blue Creek, twenty miles north of the Klamath River; owned by Thompson Bros., Requa, Cal., et al.

Higgins Mountain Group.—Five claims, situated on the Siskiyou Fork of Smith River, five miles south from mouth of Monkey Creek; owned by James Higgins, of Smith River, and James White. Development work consists of open cuts. Ore consists of high-grade copper glance, oxides, and carbonates, forming irregular shoots in serpentine.

Monkey Creek Group.—Six claims, three miles east from the mouth of Monkey Creek, on the Middle Fork of Smith River; owned by W. L. Higgins & Sons, of Smith River. Developed by short tunnels on opposite sides of the cañon. The ore is pyrite and chalcopyrite in dioritic rock. The values of the sulphide are said to range from 3 to 8 per cent in copper.

TRINITY COUNTY.

Trinity County lies in the heart of the Coast Range, and comprises a very large portion of the vast and slightly developed mineral region of Northern California, being approximately 50 by 100 miles in width and length. It lies south of western Siskiyou County, whose characteristics it shares, and its eastern boundary is the summit line dividing the watersheds of the Sacramento River and the direct Pacific slope. Humboldt County separates it from the sea on the west. The entire surface of the county is mountainous, is profusely watered by the Trinity River and its numerous tributaries, and is quite densely forested. Owing to remoteness from railroads, the great natural resources are very slightly developed. The population is sparse. The forests are practically untouched by the lumberman, and most of the county yet belongs to the public domain.

Over half the county is mineral-bearing and mining is almost the only industry. There is a vast extent of auriferous gravels accompanying the present streams and also composing high-lying ridges and benches which mark the course of an ancient river through the northern and central parts of the county. The early surface placers, now exhausted, were exceedingly rich, and at an early day the old gravel deposits referred to, in places hundreds of feet deep, began to be mined by the hydraulic process. For many years hydraulic mining has been the chief form of the industry in Trinity County, and, since the legal restriction of hydraulic mining on the Sierra slope, the largest hydraulic operations of America have been those by the Trinity, near Junction City. As the Trinity and Klamath are not navigable, hydraulic mining is here unhampered by law, and extensive new enterprises are under way. Large gravel deposits are favorably situated for gold dredging, which is assuming importance in this county.

Quartz mining has but recently begun to make general progress, though a number of important gold mines have been developed in the past, notably the Brown Bear at Deadwood, which is reported to have produced \$6,000,000. In numerous

large quartz mining districts valuable mines have within two or three years been developed, and there is much mining activity in spite of the handicap of 50 to 100 miles distance from railroad facilities. Like Siskiyou County, this is an ideal field for the prospector. One of the most important quicksilver mines of the State, the Altoona, has but recently ended a long productive career. This is the chief platinum-producing county of the State. Trinity's mineral output in 1900 was \$698,689, of which \$571,605 was in gold.

The copper prospects of Trinity County are perhaps more widely scattered than those of any other county in Northern California. They may be grouped, however, in three districts, or belts, all of which are essentially areas of peridotite. Few of the prospects are of very great magnitude, and most of them are too inaccessible for present economical working. Still, some of the prospects contain ore of high grade, and at least one of them has supplied remunerative shipments of ore. The districts may be designated as the South Fork, the New River, and the Trinity Fork.

The South Fork district includes a number of scattered prospects lying to the east of the South Fork of Trinity River, between Hyampome Valley and Rattlesnake Creek. The New River district includes a few prospects on the various branches of New River, some of which have considerable merit, and if they were more accessible would no doubt already have been worked. The Trinity Fork district includes the copper prospects to the north of Trinity Center, near Carrville, and along the main branch of Trinity River.

The expense of working these prospects is apparent when it is remembered that the ordinary freight rates from Weaverville or Trinity Center to Redding approaches \$15 per ton, while the added cost from the mines to these points is often large. In spite, therefore, of the natural advantages of timber and water power, copper mining in Trinity County has not yet progressed very far. The principal copper prospects of the county are the following:

SOUTH FORK DISTRICT.

Cold Creek Group.—Seven claims on the Cold Fork of Indian Valley Creek; owned by J. R. Bloom and D. T. Goe, Hyampome. The country is exceedingly rugged. The forma-

tion is serpentine and diorite. The ore occurs in small bodies or bunches, consisting of quartz carrying some sulphide, not of high grade. Open cuts constitute the present developments. Water power and timber are plentiful.

Lambert Group.—Three locations on the South Fork of Trinity River, near the mouth of Rattlesnake Creek; owned by Washington Lambert & Sons, Hay Fork. Ore forming small veins of chalcopyrite and pyrite in diorite. Developed by short tunnels and shaft; sulphide of good grade.

Lone Pine Group.—Two claims situated in Sec. 19, T. 1 N., R. 8 E., H. M., near the mouth of Rattlesnake Creek; owned by David Murphy and Minnie B. Murphy, Blocksburg. Ore contains some sulphide, and occurs in diorite. Some development work done.

Maddox Group.—Three claims on Cold Fork of Indian Valley Creek; owned by A. L. Maddox, Hay Fork. The formation is diorite and serpentine. The ore occurs in small bodies apparently, although but little work has been done to show its extent. The ore consists of oxides, carbonates, and sulphides carrying some gold, and is said to carry from 5 to 30 per cent of copper.

Murphy.—Two or more claims in Sec. 36, T. 1 N., R. 7 E., H. M.; owned by Minnie B. Murphy and David Murphy, Blocksburg. Developed by three shafts and a tunnel some hundreds of feet long. The formation is serpentine, and the ore occurs in veins of white feldspathic rock carrying a little high-grade oxides, carbonates, and sulphide.

Pattie.—Three claims in T. 1 S., R. 7 E., H. M.; owned by Wm. Pattie, Hay Fork. But little developed.

Vine Oak Group.—Two claims in Secs. 2 and 35, T. 1 N. and 1 S., R. 7 E., H. M.; owned by Ira P. Collins, Hay Fork. Some development work has been done. The ore is of fair grade, but in small bodies as shown at present. The country rock is diorite; the ore carries some gold.

NEW RIVER DISTRICT.

Granite Group.—Seven claims on Quinby Creek, six miles above its mouth; owned by F. C. Patton, Frank Evans, et al., Weaverville. The ore occurs in serpentine and slate at intervals along the entire chain of claims. Only a little development work has yet been done, though good ore is found and in considerable quantity. Some of the ore has a value of 25 per cent in copper, with some gold. Facilities for mining are good.

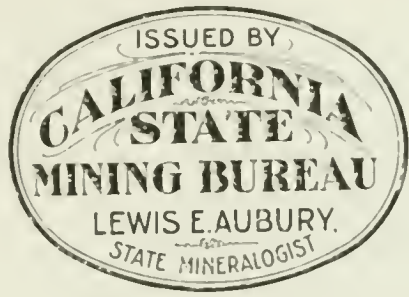
Nonpareil Group.—Four claims on the East Fork of New River, four miles above the mouth; owned by C. S. McAtes, Redding. The lode varies in width from 1 to 14 feet, but is not traced for a great distance. One tunnel on the property is 25 feet in length; not worked for some years. The croppings of gossan are said to occur along the strike of the lode for one mile. The average value of the ore is said to be about 8 per cent copper.

TRINITY FORK DISTRICT.

Cinderella Group.—Two claims in Sec. 9, T. 37 N., R. 7 W., M. D. M.; owned by P. A. Wagner and E. A. Wagner, Carrville. Developed by 300 feet of tunnels and a shaft 50 feet deep. The vein is reported to be 16 feet in width. The country rock is serpentine. Some of the ore carries 10 per cent of copper. This property joins the Copper Queen on the north.

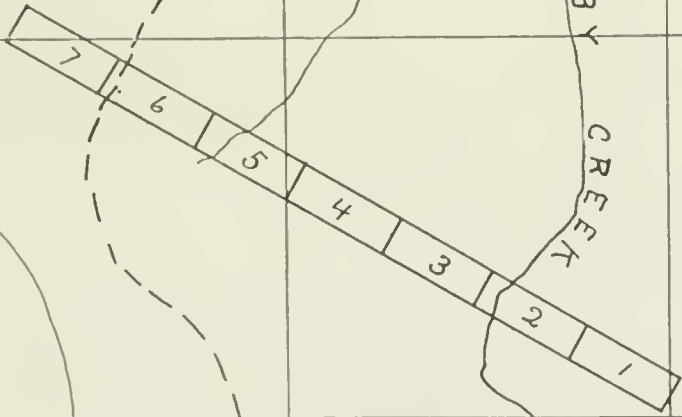
Copper Button Group.—Two or more claims located in Sec. 36, T. 37 N., R. 7 W., M. D. M.; owned by H. Z. Osborne, of Los Angeles, and Thomas Baker. Developed by short tunnels and open cuts. Ore occurs in connection with dikes of quartz porphyry in serpentine, and consists of oxides, carbonates, and sulphides. It is apparently of high grade. Idle.

Copper Queen Group.—Three or more claims situated in Sec. 16, T. 37 N., R. 7 W., M. D. M.; leased by George H. Fitch, Redding. This property is developed by tunnels and a shaft. The formation is serpentine. The ore consists of the oxides and carbonates of copper, with a little sulphide at the lower levels.



Tp. 8 N. 7 E. Hcl. M.

QUINBY CREEK



Tp. 7 N. 7 E. Hcl. M.

Crown Point Group.—Three claims in Sec. 18, T. 37 N., R. 7 W., M. D. M.; owned by George L. Carr, Carrville, and others. No work has yet been performed. The ore body is said to be very wide and to be otherwise extensive.

Eureka Group.—Two claims in Secs. 17 and 18, T. 37 N., R. 7 W., M. D. M.; owned by H. F. Dimock, of Carrville, and L. M. Hoefler et al. The ore is silicious, carrying a small percentage of copper sulphide. The property has 50 feet of tunnel.

LeBlanc Claim.—One claim on the south side of Copper Creek near Carrville; owned by George LeBlanc, Carrville. Only small amount of development; ore similar to that of the Copper Queen.

Shoemaker Claim.—One claim on East Fork of Trinity River; owned by Ed. Shoemaker, Trinity Center. Small development.

Maitland Claim.—One or more claims on Ramshorn Creek, ten miles northeast of Carrville; owned by William Maitland, Abrams. But little developed. Idle.

OTHER DISTRICTS.

Jackson & Carter Group.—Four claims in Sec. 29, eight miles southeast of Hay Fork; owned by G. W. Carter and James Jackson, Hay Fork. Developed by shaft 40 feet deep. The lode is said to be 10 to 12 feet wide, but not traced for a great distance in length. Samples of the sulphide ore have assayed 10 per cent or more in copper, with some gold and silver.

Fortuna Group.—Consists of nineteen claims of unpatented land; owned by the Fortuna Mining Company, C. Sweet, president, Fortuna. Situated five miles from Humboldt County line, thirty miles from Bridgeville. Small amount of development, but shows conspicuous gossan croppings; accessible from Fortuna, Humboldt County. This property is near the Copper Queen group, near the head of Van Duzen River. Development work is in progress.



CROPPINGS 60 FEET WIDE, ISLAND MOUNTAIN COPPER MINE.



CROPPINGS 130 FEET WIDE, ISLAND MOUNTAIN COPPER MINE.

Iron Mountain Claim.—Consists of one claim, situated three miles southeast of the Copper Queen, near the head of Van Duzen Creek; developed only by open cuts; some low-grade carbonate ore exposed. Owned by Turner & Co., Dyerville, Humboldt County.

Copper Queen Group.—Consists of six claims, situated in Secs. 10 and 11, T. 1 S., R. 6 E., H. M., and thirty-five miles southeast of Bridgeville, Humboldt County; owned by Joseph Hutchens, Anada, Trinity County. Developed by one 40-foot tunnel and some open cuts. Sulphide ore has been encountered in the tunnel, and gossan croppings are abundant. Development work was in progress.

Black Palangus Group.—Situated in Sec. 36, T. 1 N., R. 6 E., H. M.; owned by Joseph Hutchens and Brothers, Anada, Trinity County. Developed by open cut 60 feet long, showing good copper ore, some of it reported to assay 17 per cent copper. Croppings are bold, and about 20 feet in width. This property is one mile east of the Copper Queen group.

Island Mountain Consolidated Copper Mine.—This important but slightly developed property, with its quite remarkable outcroppings, is situated ninety miles north of Ukiah, just over the Mendocino County line. It lies by Eel River in Secs. 9, 10, and 15, T. 5 S., R. 6 E., H. M., in the Horseshoe district, and comprises seven claims—the Leach, Shotgun, Annex, Island Mountain, Merritt, Gore, and Day. The development work consists of one cross-cut tunnel running north 490 feet, one running on the vein northwest 40 feet, and several open cuts across the outcrop. The croppings can be traced for 800 feet, and are in places 130 feet wide. The vein has a northwest and southeast trend. The southeast end line starts on the north bank of Eel River, and the claims extend northwest diagonally across Lake Mountain to the south bank of Eel River, the river making a horseshoe bend. The vein is capped with large boulders containing much copper and iron sulphides. Slides have occurred and many boulders have found their way to the river-bed, a distance of 500 to 700 feet. One boulder, imbedded about 100 feet north of the river bank, is 60 feet across the base, and is estimated to contain 4500 tons of copper sulphide ore. Large boulders



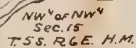
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T. 5 S., R. 6 E., HUMBOLDT MERIDIAN.





BOWLDER OF COPPER ORE 60 FEET ACROSS BASE, 30 FEET DEEP, 25 FEET ACROSS TOP ISLAND MOUNTAIN COPPER MINE, TRINITY COUNTY.



BOWLERS OF COPPER ORE, ON NORTH BANK OF EEL RIVER, FROM OUTCROP 500 FEET DISTANT. ISLAND MOUNTAIN COPPER MINE, TRINITY COUNTY.

1875

WINDMILL HILL, NEW YORK

1875

1875

1875



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BOWLDER OF COPPER ORE 60 FEET ACROSS BASE, 30 FEET DEEP, 25 FEET ACROSS TOP. ISLAND MOUNTAIN COPPER MINE, TRINITY COUNTY.



BOWLDER OF COPPER ORE, ON NORTH BANK OF EEL RIVER, FROM OUTCROP 500 FEET DISTANT. ISLAND MOUNTAIN COPPER MINE, TRINITY COUNTY.

have accumulated along the north bank of Eel River for 500 feet, and one weighing 160 pounds is reported to have yielded 10 ounces in gold, 5 ounces in silver, and $4\frac{1}{2}$ per cent in copper per ton. The long tunnel was started 50 feet north of the river bank, and extended across the country rock 490 feet with the view of cutting the vein. This work was done in 1899, by the London Exploration Company. No timbers were put in. The rains made the ground heavy and the tunnel is now caved at several places. In 1900 the shorter tunnel was run 40 feet, and its face is now in solid sulphide ore. As far as the vein is exposed on the level, it has the appearance of dipping into the mountain at a very low angle. The long tunnel has not been extended far enough north to penetrate the vein, providing it extends to this level. The country rock on the hanging wall is soft sandstone and the foot wall calcareous shale. Several trenches from 3 to 5 feet deep have been made across the outcrop, northwest of the 490-foot tunnel, showing the croppings to be from 60 to 130 feet wide. The water running from the tunnel is highly impregnated with copper. The elevation at the mouth of the long tunnel is 1300 feet, and on Lake Mountain, where the croppings cross, 1700 feet. The country rock to the north, down the slope of Lake Mountain, is composed of serpentine and sandstone. Island Mountain is on the south side of Eel River and directly opposite the claims. Owner, Island Mountain Consolidated Copper Company, San Francisco.

HUMBOLDT COUNTY.

The scattered copper deposits of the Coast Range extend, to a slightly known degree, into the coast county of Humboldt, which stretches for about 100 miles along the ocean shore south of Del Norte and reaches 30 to 40 miles eastward into the mountains to adjoin Trinity County. This county, chiefly famed for its redwood lumber and dairy industries, is one of the minor mineral-producing counties of the State, though it has extensive undeveloped mineral resources. For forty years it has held out the promise of showing a large and valuable oil-field

neighboring the ocean, and on its shores has, since early days, been the chief scene of beach placer mining on the Pacific Coast. It has numerous coal deposits of prospective value. Along the Klamath, at the northern end, some hydraulic and other placer mining operations have proceeded for a great many years.

A large portion of the county, embraced in its eastern part, is mineralized and depends mainly on its minerals for whatever future industrial development it may know. Low-grade auriferous veins occur. This eastern portion of the county, throughout its length, is in general much broken, unsettled, remote, difficult of access, and little explored for minerals. It is densely forested, is full of streams, and being on the western slope, has a heavy rainfall. These and other characteristics it shares with western Trinity. The county has two short local railroads near the coast, but communication with the outside world is through the harbor of Eureka. The mountainous eastern portion is poorly supplied with roads and trails.

It is in a region of this nature that Humboldt's known copper deposits occur, and in their kind and occurrence they resemble those of Del Norte and Trinity counties. The copper claims now held may be grouped in three districts. The best known are in the extreme northern part near the Klamath River. At the head of Red Cap Creek, south of the river and on a high ridge, are copper indications which have caused considerable expenditure in prospecting in the past and which are again being explored. Large pieces of bornite and native copper occur as float. North of the river, near the headwaters of Camp Creek, large bodies of low-grade ore are reported. Well toward the southeastern portion of the county, in the neighborhood of Lasseck Peak, are extensive surface showings of copper ores. This is northwest of the Mad River district across the line in Trinity County. West of Lasseck Peak, and not far from the coast, are groups of claims showing carbonates and but slight development. The leading copper properties of these districts are noted.

Red Cap.—This property consists of 57.66 acres in Sec. 29, T. 10 N., R. 6 E., H. M. It is situated 67 miles northeast from Eureka, and is reached by railroad 20 miles to Blue Lake, thence 17 miles to Blairs by wagon-road, and thence 30 miles

by pack trail. In the year 1880 considerable work was done on the property in running tunnels, but no vein has ever been found in place. Many specimens of native copper have been found at the base of the mountain in Boise and Red Cap creeks. The contact is very prominent for the entire length of property, serpentine being the foot wall and diorite being exposed on the hanging wall. Abundance of timber and wood is growing on the property. Red Cap and Boise creeks afford plenty of water for all practical use. The elevation at the base of the mountain is 450 feet, and on the ridge, where the contact is prominent, 2150 feet. The strike of the contact is north. On the west side of the contact, slides have taken place for several hundred feet down the mountain, and evidently the rich float that has been found on Red Cap and Boise creeks came with the slides. The company is now arranging to place men at work in a more intelligent manner than heretofore. Orleans Bar, the nearest postoffice, is seven miles distant. Owners, J. R. Dollison, of the Eureka Bank, and others, Eureka, Humboldt County.

La Perin Group.—Joins the Red Cap mine on the north, displays same formation, and consists of ten mineral locations on the strike of the contact, which is north. When inspected, work of preparation for running a tunnel was proceeding. Owner, J. La Perin, Orleans Bar, Humboldt County.

Red Lasseck.—Situated seven miles southwest of the Copper Queen group in Trinity County, in T. 1 S., R. 4 E., H. M., and is on the south side of Lasseck Creek, at an elevation of 5800 feet. This is a recent location and was being developed by an open cut. The croppings appear of an oxide nature, reported to yield 9 per cent in copper. The formation of both walls is serpentine. The property can be reached over a trail from Blocksburg, Humboldt County, a distance of seven miles. Owners C. B. Bulger and others, Anada, Trinity County.

Rainbow Group.—This property, consisting of nineteen claims, is situated in the Mattole Mining District, 60 miles south of Eureka, in Secs. 19, 30, and 32, T. 1 S., R. 1 E.; also in Secs. 12 and 19, T. 1 S., R. 1 W. The sea coast is 14 miles west. The Eureka & Eel River Railroad runs to within 30

miles at Scotia. About the center of these claims an open cut has been extended 60 feet across, the vein matter showing carbonate ore in many places in the cut. Several trenches on the outcrop show the same character of ore for several hundred feet along the strike of the croppings. On the north end of this property a creek, tributary to Bear River, runs diagonally across the property, and has cut a deep gorge through the veins, showing carbonates somewhat extensively 100 feet in width. Wood and water are plentiful. A cross-cut tunnel was being run with the expectation of tapping the ore body 200 feet from the surface. The property is owned by an incorporated company (C. S. Taylor president, and H. L. Ford secretary) of Eureka, Humboldt County.

Crismon Group—Consists of 80 acres of patented land; joins the Rainbow group of mines on the south, and is in Sec. 8, T. 2 S., R. 1 E., H. M. Several prospect holes have been sunk at intervals over the 80 acres, and carbonate ore has been found. When visited, sufficient development work had not been done to demonstrate the width of the ore, neither could any walls be traced. The same situation prevails as at the Rainbow group as to wood, timber, and water. A. H. Crismon & Son, owners, Pepperwood, Humboldt County.

TEHAMA, GLENN, AND COLUSA COUNTIES.

South of Shasta County and the head of the Sacramento Valley, the eastern slope of the Coast Range is, for a long distance south, embraced in the western portions of the three large Sacramento Valley counties of Tehama, Glenn, and Colusa, the western boundaries of which are along the range summit. Tehama reaches across to the Sierra slope, and the others have the Sacramento River for their eastern boundaries. These counties are preëminently agricultural and horticultural, and have cut small figures in the mineral industry of the State, though, especially in the case of Colusa, this has been because varied and valuable mineral resources have been but slightly exploited. Their mineral resources are found along the Coast

Range slope, which displays similar topographical, geological, and other characteristics throughout the three counties. This slope is fairly well watered, poorly wooded, and slightly settled, except in small fertile valleys. The lower foothills through the three counties present a long belt showing promising indications of petroleum and natural gas, which have for many years been the subjects of more or less prospecting. Along this slope, at higher altitudes, various mineral substances have long maintained attention that has generally been unrewarded. Nature has been most generous with Colusa in this regard, and its western portion from valley plain to range summit displays, besides oil, well-known occurrences of quicksilver, sulphur, coal, mineral waters, gold, copper, building-stone, etc., many of which are now receiving attention and inducing considerable investment. In 1900, Colusa produced some quicksilver and mineral water, Glenn yielded no minerals, and Tehama was credited with only brick.

Through these counties the known copper deposits are ranged in a north and south belt, high up on the slope, parallel with the range and about 50 miles west of the Sacramento River. This belt runs from the west-central part of Tehama County south through Glenn into the northeastern portion of Colusa County, whence it is prolonged into Lake County, and its course through the three valley counties is about 60 miles in length. The deposits to be noted are mainly in the columns of townships numbered 6 and 7 west, M. D. M., some others lying in T. 8 W. All are but a few miles below the summit line. This zigzag line of deposits follows a serpentine belt, and the copper ores are characteristically found inclosed in serpentine. The copper exists in various mineral forms, those most frequently noted being red and black oxides and carbonates, while native copper in the form of float is found at various points. The ores frequently carry some gold, and they generally occur in narrow and often rich seams between layers of serpentine, but the deposits opened so far have been small.

Copper deposits in Colusa and Glenn counties were first discovered in the early sixties, and this region shared the general copper excitement of that period. Two attempts at reduction in small smelters in the sixties and seventies, respectively, failed because the processes were not adapted to the ores, and no

profitable or notable operations have ever been conducted in these counties. Some slight shipments of ore have been made in past years, and quite a number of claims have been opened to a small extent, but all exploration to date has been superficial and little is known of the value of the copper belt described. The frequent richness of the ores suggests the probable worth of a large deposit if one were discovered. These deposits are now causing considerable prospecting activity, but little in the way of development. Those described in the following notes are the chief ones now held and known as copper propositions, but they cover a small part of the mineralized belt in which they belong.

TEHAMA COUNTY DEPOSITS.

Kestner & Thompson are engaged in prospecting a claim in Sec. 4, T. 27 N., R. 7 W. They have three tunnels 58, 27, and 27 feet long respectively. The vein, 4 to 5 feet in width, is in serpentine. Now idle.

Elder Creek Groups.—In Sec. 20, T. 25 N., R. 7 W., and in Secs. 9, 10, 15, and 16, T. 24 N., R. 7 W.; comprise three claims owned by W. Richards, five claims belonging to F. T. Notz, three claims to A. Henley, and three claims to George W. Cooper. All show some copper indications, and all have but little development.

L. E. Perine was working on copper stringers in Sec. 25, T. 27 N., R. 8 W.

White Bluff Group.—In Secs. 4, 5, 8, and 9, T. 25 N., R. 7 W.; belongs to B. N. Huestis, of Red Bluff, and consists of six claims. They are in the chrome district. Some copper indications. Now idle. Slight development.

GLENN COUNTY DEPOSITS.

Hudibras Claim.—In Sec. 1, T. 19 N., R. 7 W. The formation is serpentine. A shaft 6 feet deep shows some copper indications. Owner, Briscoe Oil and Mineral Company. The same company owns land in Secs. 2, 11, 12, and 13, whereon copper indications occur.

H. D. Knight owns land in Secs. 18 and 19, T. 19 N., R. 6 W., showing copper indications.

St. John Development Co.—Owns land on which there are iron-capped copper indications in Sec. 18, T. 18 N., R. 6 W.

Indications similar to the above occur in Secs. 12, 13, and 24, T. 18 N., R. 7 W.

Black Buttes Copper Claim.—In Secs. 30 and 31, T. 24 N., R. 8 W. Owner, J. A. Bedford, who is now working the prospect. There are here fine indications of red oxide scattered around in bunches, but no vein. Nothing is being done in this county farther north than this.

There are the remains of an old town, Peckville, in Sec. 18, T. 18 N., R. 6 W., where in the sixties there was a large amount of prospecting for copper and gold. Old tunnels and shafts are frequent. To the north of Chrome Mountain, two miles, A. W. Lehorn owns claims where there are good copper indications; formation serpentine. Development consists of a tunnel 200 feet long. Large pieces of native copper are here found, some weighing about two pounds.

South from the Black Buttes, along Grindstone Creek, and following the creek 25 or 30 miles to Stony Creek, it is all a copper mineralized country.

COLUSA COUNTY DEPOSITS.

Gem Group.—Located by W. W. Heard and others, consisting of fourteen claims in Sec. 28, T. 16 N., R. 6 W. Nearby are two claims owned by Raymond Houx and Edward Swinford, all showing indications of copper.

Blackbird.—Owned by C. L. Heard et al.; in Secs. 19 and 20, T. 16 N., R. 6 W. Ledge is in serpentine. Small development.

Gray Eagle.—The most important location in this neighborhood is owned by W. N. Heard and J. W. Simons. It lies in Sec. 20, T. 16 N., R. 6 W. It is developed by open cuts and a shaft 20 feet deep. The vein formation is of unknown width, but a seam of copper-bearing rock is exposed that shows from

18 to 48 inches in width. This does not yet appear to have much regularity. A tunnel run 200 feet does not reach the vein in depth. The ores are native copper in serpentine and red and black oxides. Along the lode ores carrying native copper can be found as float.

Pacific Claim.—It is about two miles southeast of the Gray Eagle, in Sec. 28, T. 16 N., R. 6 W. Here a shaft was sunk 50 feet on a bunch of ore, which was then all extracted and



GRAY EAGLE COPPER CLAIM, COLUSA COUNTY.

shipped. There are two other shafts, one 25 feet, the other 45 feet deep. The formation is serpentine, and the ores are oxides of iron and copper, carrying some gold.

There are several other prospect holes, showing small amounts of copper ores, in T. 16 N., R. 6 W.

Ruby King Copper Mining and Townsite Co.—A Sacramento corporation owns and has opened eleven claims in Secs. 29 and 32, T. 17 N., R. 6 W. No great development,

and no large deposits are yet shown. The principal indications on this group are float copper.

On the ground of the Mark Hanna Oil Company, in Sec. 35, T. 17 N., R. 7 W., there are indications of copper ore.

Lion Mine.—On this old property, the present owner of which is J. F. Easton, there has been considerable work done in the past.

MENDOCINO COUNTY.

Mendocino County knows little of the mineral industry in any of its forms, but carries various economic minerals in its mountains, prominent among which is copper, of which many surface showings occur. The county occupies about 85 miles of the coast line south of Humboldt, and in its widest part reaches 60 miles eastward to the summit of the Coast Range, where it meets the valley county of Glenn. Its southern half shares the higher mountain region with Lake County. Mendocino has rich agricultural valleys, the chief ones being those of the Eel and Russian rivers. The redwood belt extends through the county, and lumbering is the chief industry. The lower elevations afford extensive grazing lands. Mineral springs and an extensive undeveloped coal region in the northern part provide the best known mineral features.

Copper occurrences are sporadic and form no "belts." They are found along the eastern side of the county and across the southern end to the range nearest the coast. As elsewhere in this general coast region, they vary in nature, displaying carbonates most frequently and occurring in metamorphic formations. Several prospects display rich ores in small quantity, but the prospecting that has been carried on intermittently for many years has not yet revealed any notable deposits.

In the northern part of the county, the Thomas property has been long prospected because of rich indications, but no large ore bodies have been found in place. Promising indications are reported from Potter Valley in the east central part. Most of

the known prospects are in the southern, and especially the southeastern portion, south and east of Ukiah, the county seat, near the Lake County boundary.

Thomas.—On Bralt ridge, at the edge of Eden Valley, fifty-five miles north of Ukiah and three miles south of Carey. A mass of rich sulphides of iron and copper has caused considerable prospecting in search of a vein, which has not been found.

Native Copper.—On Red Mountain, twelve miles southeast of Ukiah. A shallow cut shows a stratum of serpentine about 3 feet wide, carrying native copper and copper minerals. The stratum is inclosed in serpentine. Abandoned.

Red Mountain Group.—Four claims, ten miles southeast of Ukiah, in Sec. 23, T. 15 N., R. 11 W. Apparently two veins exist. These claims were located in 1890, and relocated from time to time. The formation is principally serpentine. One claim is developed by an open cut and cross-cut tunnel. Several small bunches of ore have been found in the cut, showing green carbonates and metallic copper. An adjoining claim is developed by two shafts 100 feet and 50 feet deep and by an incline. From one shaft, above the 50-foot level, bunches of carbonate ore were taken out in 1896. One ton of ore shipped to San Francisco yielded \$12 in excess of transportation and working charges. The shaft was extended to the 100-foot level, showing no ore, the bottom being in broken sandstone and clay. From an incline several tons of low-grade ore have been taken out. Other openings have yielded nothing of interest. The property has remained idle since 1896. The company was arranging to resume operations by starting a cross-cut tunnel on the east side of the mountain to cut the vein 200 to 300 feet below the old workings. Owners, Huff & Gibson, Ukiah.

Ogle.—This mine is situated in the Anderson Valley district, comprises 2000 acres of patented land, in T. 13 N., R. 12 W., and joins the Redwood Copper Queen mine on the north. Recently this land was bonded to Cloverdale people. A shaft 16 feet deep on the center of the claim exposed carbonate ore. Not enough work has been done to demonstrate the width of the

vein or the formation of the walls. Gossan 2 to 3 feet wide can be traced for one mile through the claim. It was the reported intention of the parties having the option to erect a horse-whim and explore the property to deeper levels. The conditions attending the Redwood Copper Queen obtain. Owners, Ogle Brothers, Orinda, Mendocino County.

McGimpsey.—In Secs. 17, 13, and 18, T. 13 N., R. 12 W., fifteen miles southwest of Ukiah, comprising eight full claims. Four shallow open cuts measure the prospecting done. The formation is serpentine. The open cuts have exposed considerable copper stains and in a few places some red oxide of copper mixed with oxide of iron. The work so far shows no vein or fissure, only an irregular diffusion of cupriferous material through the mass of eruptive rocks. Parties were arranging to explore the property on a deeper level by running a cross-cut tunnel on the west slope of the hill. Owner, C. P. McGimpsey, Ukiah.

Pieta.—One claim, ten miles northeast of Cloverdale, four miles from the Sonoma County line. It is developed by an open cut 55 feet across the vein matter. Croppings can be traced through the claim, the strike of the mine being east. The ore carries a slight trace of carbonate of copper, the gangue matter is mostly magnetic iron, and serpentine is the formation of both walls. Only assessment work has been done. Owners, J. G. Caldwell et al., Healdsburg, Sonoma County.

Redwood Copper Queen.—Consists of 840 acres of patented land in Secs. 17 and 20, T. 12 N., R. 13 W., M. D. M., and is thirty-five miles southeast of Ukiah. The development work consists of nearly 200 feet of tunneling to a point in the vein where a chamber has been excavated 16 feet square, exposing sulphide ore. Two winzes have been sunk at this point, 100 and 36 feet respectively. The vertical 100-foot winze was started near the foot wall, and sulphide ore exposed the entire depth. The foot wall having been encountered at this level, work was then abandoned, and a second winze started. It is on an incline of 65 degrees northeast and showing sulphide ore. The lode is very much broken, and the walls very irregular, caused doubtless by faults that are prominent on the surface. The walls on the tunnel level are respectively broken porphyry and sandstone. A gossan cap-

ping 2 to 4 feet wide can be traced one mile through the property. The surface soil is in some places from 6 to 8 feet deep. The ore carries gold, silver, green and blue carbonates,



REDWOOD COPPER QUEEN MINE, MENDOCINO COUNTY.

black and red oxides, gray copper and copper pyrites, and 250 tons of ore are now stored on the dumps. The company is a San Francisco corporation. W. P. Ferguson, president; Thomas Mellersh, secretary and treasurer, San Francisco.

LAKE COUNTY.

Lying wholly within the Coast Ranges, with the line dividing the watersheds of the Sacramento River and the Pacific for its eastern boundary, inclosed between two ranges and containing an especially rugged portion of this mountain system, Lake County has varied mineral resources, though its mineral output is relatively small. Its many scenic attractions have made it called a little Switzerland. It is a region of much and recent volcanic action. It has many mineral springs, some of which are famous resorts, and by these Lake County is mainly known to the outside world. Cinnabar is its chief mineral resource, and it is now one of the important quicksilver counties. Its other minerals are gold, silver, copper, borax, sulphur, asbestos, chrome, natural gas, etc.

The cupriferous belt passing through Tehama, Glenn, and Colusa counties reaches into Lake at the north. Here, near the head of Little Indian Valley, a mineralized belt carrying copper extends several miles, and at one time there was quite a copper excitement caused by the finding of large pieces of native copper and rich oxide ores. The Lyon property gave rich prospects and several thousand dollars were lost in an ill-managed attempt to smelt the ores. Copper is elsewhere mainly found in the southern portion of the county below Clear Lake, and in the central west near the head of Clear Lake and across the line from the chief copper occurrences of Mendocino County. Three properties are noted.

Copper Prince Mining Co. — Property consists of three claims, four miles northwest of Middletown, in Sec. 19, T. 11 N., R. 7 W., in the southern part of the county. Developed mainly by one tunnel and two open cuts on the vein, showing the vein to be from 6 to 8 feet wide, with limestone walls. Heavy gossan can be traced through the claims. The company was surveying on the north slope of the ridge preparatory to starting a tunnel with the view of cutting the vein on deeper levels. The ore on the tunnel level is impregnated with blue and green carbonates, and is reported to assay 5 per cent in copper, \$3 in gold and 1 ounce of silver. President, E. Lobree; Secretary, J. C. Ruddock, Ukiah.

Christianson Tract.—This comprises 294 acres in T. 13 N., R. 7 W., and is three miles south of Clear Lake. Considerable float has been found on the low lands, evidently coming from the high ridges that are somewhat prominent throughout the tract. Several pieces of the float have been assayed, and are reported to contain 65 per cent copper. In 1879 a tunnel was run about the center of the ranch, 112 feet north on a contact of serpentine and limestone, but no vein was found in place. Owner, Peter Christianson.

Poe Claim.—Seven miles north of Lakeport, in Sec. 27, T. 15 N., R. 10 W., a shaft of 35 feet was sunk and a tunnel of 65 feet, now caved, was run in 1870. In 1900 parties relocated and ran an open cut 25 feet long on the south end croppings. The vein is 5 feet wide, in a serpentine belt, and shows a light trace of carbonates. There are ten sulphur springs at the north end of the property. Owners, H. B. Wells, A. Smythe, and James Lee, Lakeport.

NAPA COUNTY.

Napa County is one of the most favored and fertile counties of the Coast Range region. It lies south of Lake County and east of Sonoma, and reaches south to San Pablo Bay. Topographically it is mainly composed of the rich and populous Napa Valley and of two flanking mountain ranges. At the head of Napa Valley, at the northern end of the county, is Mount St. Helena, altitude 4343 feet, the highest point in this part of the Coast Range. Napa is mainly a fruit, grain, and vine-growing county, but it also possesses a variety of mineral resources, those of greatest present importance being quicksilver and mineral waters. In the northern portion of the county are some of the important quicksilver mines of California, and some of its mineral springs are widely known. Other mineral resources are gold, silver, chromium, iron, manganese, and building-stone. In 1900 Napa County's mineral output amounted to \$493,100, and in 1899 to \$701,416. Copper occurs sporadically, as in adjoining counties. Two deposits are noted.

Napa Copper Claim.—One claim, situated thirteen miles south of Middletown, in Sec. 17, T. 10 N., R. 5 W.; developed by a cross-cut tunnel south 400 feet. A gossan capping can be seen through the entire plain. Several years back a shaft was sunk 50 feet on the west end of the plain, and reported to have encountered several bunches of high-grade sulphide ore. Recently a new corporation was organized, and work was resumed. A 700-foot tunnel was started on the north side of the mountain with the view of cutting the vein 300 feet from the surface. When visited work was temporarily suspended, with the tunnel at 400 feet. The country formation is serpentine. Owners, Napa Copper Company—Owen Wade, president; T. A. Taylor, secretary, St. Helena.

Search Group.—This property consists of eight continuous claims, seventeen miles north of Napa, in Sec. 5, T. 6 N., R. 5 W. Very little work has been done. There has never been any vein found in place, although considerable float, consisting of sulphides, has been picked up on the slope of the mountain. The formation is serpentine. Several years ago several cross-cut tunnels were run north, but were not extended far enough to encounter the vein. The capping has an east and west trend, is 2 to 4 feet wide, and is sprinkled with blue and green carbonates. No work is now being done. Owner, E. F. Rossan, Glen Ellen.

SONOMA COUNTY.

Quite a number of copper deposits of minor importance, as far as developed, are found in the bay county of Sonoma, which lies for nearly 60 miles along the sea south of Mendocino, extends back some 40 miles to the summit of the main Coast Range, opens on San Pablo Bay at its south, and leaves the small county of Marin occupying the peninsula opposite San Francisco. The county is traversed by several low north-and-south ranges, and possesses some of the largest and most famous of the horticultural and agricultural valleys of the State. These fertile valleys are the chief fountains of its life and wealth. The redwood belt near the coast supports an

extensive lumber industry. Of minerals, the county possesses a variety, quicksilver and mineral waters being the only ones commercially produced. There are slight occurrences of gold and silver, and scattered deposits of iron, coal, manganese, mineral paint, chrome, clays, building-stones, etc.

The copper ores discovered form no connected belt, but occur within two vertical tiers of townships through the central region of the county. The occurrences are similar to those of adjacent coast counties. Several prospects have been opened by superficial shafts, tunnels, and cuts, a few tons of ore taken out and slight experimental shipments made in past years. Several properties have lately been re-opened.

Wall Tract.—Consists of 200 acres of patented land five miles southwest of Santa Rosa, in Sec. 30, T. 8 N., R. 9 W. Several pieces of rich copper float have been found on the tract, but as yet no vein in place. A shaft 10 feet deep has shown native quicksilver. Owner plans investigating copper possibilities at some depth. Owner, H. C. Wall, Hilton, Sonoma County.

Archer Tract.—This tract joins the Wall tract on the north, and comprises 288 acres of patented land in T. 8 N., R. 9 W. In 1880, considerable rich float was found and shipped, and two tunnels run north on the contact, 250 feet apart, for a distance of 200 feet. No vein was found in place. The tunnels were abandoned and are now caved in. Interest was lately renewed, owing to rich float being again found. The owner was arranging to sink a series of prospect holes on the tract to see if a vein can be found in place. The formation is serpentine and sandstone. Owner, J. H. Archer, Healdsburg, Sonoma County.

Healdsburg Lode.—One claim, ten miles north of Healdsburg, on Black Mountain, in Sec. 31, T. 11 N., R. 9 W. A very prominent gossan cropping extending several feet above the surface runs through the claim. The property was opened seventeen years ago by a tunnel which penetrated nothing but limestone. The owners were running a cross-cut tunnel on the west slope of the mountain, with a view of cutting the vein 100 feet from the surface. The elevation on the summit of

Black Mountain is 2500 feet. Developing. Owners, Ed. Ellis and J. G. Caldwell, Healdsburg.

Grizzly Claim.—This property, ten miles northwest of Healdsburg, is situated on Pine Creek, in T. 9 N., R. 10 W., and was recently relocated. Croppings, principally quartz, carry copper stains. Old works consist of two caved tunnels on the south slope of the mountain 200 feet apart, running west 100 feet. The owners were preparing to open the lower tunnel with the view of extending 100 feet, to get under the croppings. The formation is sandstone on the north and serpentine on the south. Owners, C. F. Brandt et al., Healdsburg.

Ward Tract.—Consists of 591 acres of patented land, five miles west of Healdsburg, in Sec. 22, T. 9 N., R. 10 W. Gossan croppings can be followed for one mile eastward through the tract along a contact of limestone and serpentine. Some very rich copper float has been found on the tract, but no vein has been discovered in place. Developments, one shallow cut. Owner, J. W. Ward, Healdsburg.

Altamont Group.—This property is eighteen miles northwest of Santa Rosa, in Sec. 17, T. 7 N., R. 10 W. It is a recent location, and is developed by an open cut and shaft. The croppings consist of a gossan capping several hundred feet in length, which exposes a vein, 5 feet wide, of copper carbonates. Owners were preparing to drive a tunnel from face of open cut 100 feet, to give 80 feet of backing. The formation on both sides of capping is serpentine. At the end of the open cut a shaft has been sunk 15 feet vertically on the vein matter, but is now filled with water. Owners, J. D. Connelly, James Owens, H. M. LeBaron, Occidental, Sonoma County.

Baby Jack and Earl Clare.—Situated seven miles northwest of Healdsburg and two miles west of Dry Creek, in T. 9 N., R. 10 W. In 1875 these claims were worked and several tons of copper ore shipped to San Francisco. Later, they were abandoned and relocated from time to time. The Baby Jack is developed by a 35-foot tunnel at the south end, on the strike of the outcrop, the face giving about 35 feet of backs. About the center of the claim a vertical shaft has been

sunk 22 feet on the vein. The gangue of the vein is principally quartz carrying no copper sulphides, but stained somewhat with blue and green carbonates. The formation on the east is limestone, on the west serpentine. Considerable timber is growing on the claims. Only assessment work is now being performed. Owner, C. C. Echlin, Santa Rosa.

MARIN COUNTY.

The small coast county of Marin, lying across the Golden Gate from San Francisco, presents a few small copper deposits among its slightly developed mineral resources, which include oil, gas, small seams of coal, iron, manganese, chrome, building-stones, and clays. Brick and rubble are the only current mineral products. Nearly forty years ago two copper deposits close to the shore, between Mount Tamalpais and Bolinas Bay, were opened by tunnels and later abandoned. One, in Union Gulch about three miles north of Bolinas, was opened in 1863 by the Union Copper Mining Company, which shipped several tons of ore for reduction. Efforts to develop a profitable supply of ore lasted seven years. In 1863 the Pike County Gulch Copper Mining Company opened another mine a mile south of the Union in Pike Gulch. During three years a 700-foot tunnel was run, but the enterprise was abandoned. In this neighborhood there is a 4-foot vein cropping carrying iron pyrites and covering low-grade copper ore. The ores in these deposits occur in veins, associated with quartz and lying in metamorphic sandstone.

Bolinas Copper Mining Co.—This company has recently been exploiting a copper property in the region described, four miles northeast of Bolinas Bay, in Sec. 1, T. 1 N., R. 8 W., and twenty miles from San Francisco. The property consists of nine parallel copper-bearing veins encased in serpentine. The veins trend northwest, are vertical, and are from 6 inches to 2 feet in width. On the western vein a shaft has been sunk 180 feet, and from it 2500 feet of drifts have been driven north and south on the 100- and 180-foot levels. The shaft is

equipped with a good thirty-horse-power hoisting plant. A building 50 by 100 feet in size, to contain a concentrating plant, has been erected. The machinery thus inclosed consists of a set of Cornish rolls, a rock-crusher, two concentrators of the Springer type, and engine and boilers. Now idle. In former times, short tunnels were run on the veins to test their values, but now these tunnels are caved. About 200 tons of ore is stored on the dumps and is reported to contain from 5 to 10 per cent of copper. The owner is the Bolinas Copper Mining Company; T. P. H. Whitelaw, president and manager, No. 253 Spear Street, San Francisco.

ALAMEDA COUNTY.

Alameda, a rich and populous county lying on the eastern side of San Francisco Bay, made up topographically of fertile valleys and low ranges of the Coast system, has quite recently added copper to the list of economic minerals counted among its resources. It has for some time possessed the largest and best developed coal mine of the State, the Tesla mine at Corral Hollow, and it has been an important producer of salt, manganese, clays, building and paving stones, etc. Recently a copper-bearing lode was discovered a few miles east of the bay shore, close to the city of Oakland and directly across the bay from San Francisco. An exposition of it is contained in the following descriptions of the two properties in which development has occurred:

Alma Mine.—This property embraces over 80 acres of land belonging to the Boehmer ranch, four miles east of Broadway, Oakland. Its present development has been undertaken by the Stauffer Chemical Company of San Francisco, and consists of about 600 feet of tunnels, with some unimportant shafts and open cuts. The ore body thus far explored forms a shoot of solid pyritic ore ("black pyrites"), apparently lenticular in shape, having a thickness of 12 to 18 feet. The other dimensions of the shoot have not yet been shown, but it has been followed for more than 100 feet along its strike

in a northwesterly and southeasterly course. Other shoots have been proved, but not yet explored, in the near neighborhood. They occur along a zone or belt of indefinite width, ranging with the strike of the ore and crossing the cañon of Redwood Creek. The belt has been traced for a distance of about 3000 feet, including the deposits of this and the following property. The whole amount of ore available upon this property is very great. The ore zone follows very nearly along the line of contact between serpentine and a silicious rock resembling a metamorphosed chert. Croppings of gossan also occur outside of the direct line of the main ore zone. The ore from this mine consists of the simple sulphide of iron and copper, the percentage of copper being low, ranging, it is said, between $1\frac{1}{2}$ and $3\frac{1}{2}$ per cent, and carrying gold to the value of about \$2.50 per ton. The ore is mined chiefly for its contents of sulphur, of which it carries about 45 to 50 per cent. A representative analysis of the ore is given by the Stauffer Chemical Company, as follows: Sulphur, about 50 per cent; copper, 3 per cent; gold, \$2.50, and silver one ounce per ton; silica, traces; balance, iron. The ore is shipped from the mine directly to the acid works of the Stauffer Chemical Company, or to supply the demands of other chemical companies depending upon the use of pyritic ores for their source of sulphur. The Peyton Chemical Company of San Francisco is a large consumer. About 60 tons of ore is being shipped daily from the mine at the present time. It is proposed to extract the copper from the roasted ore by a process of leaching. This mine is important, not only for the present and prospective value it contains within itself, but from the fact that its development opens up the probability of still other similar deposits in this region, where similar geological conditions are not uncommon.

Leona Heights Mine.—To the south of the Alma mine and on the strike of its ore-bearing zone, is the mine owned and operated by the California Improvement Company, under control of the Realty Syndicate of Oakland, of which F. M. Smith is president. The ore body of this mine is similarly situated and is similar in character to that of the preceding property. It is developed by about 200 feet of tunnels,

showing a shoot of ore about 12 feet in thickness. The cropings of gossan (limonite) are very conspicuous at the surface. The ore will be used in the manufacture of sulphuric acid, or sold to supply the demand for such ores among the various chemical companies in the vicinity of San Francisco.

MERCED COUNTY.

Jose Copper Claim.—Located in the Coast Range in Sec. 4, T. 14 N., R. 9 E., about thirty-five miles east of Hollister, the nearest railroad station. The development has exposed quite a body of ore, but so far the ledge has not been located. There is a tunnel 500 feet long, but little ore was encountered. A 30-foot shaft was sunk and a drift run about 60 feet, exposing a good body of copper ore. The ore was chalcopyrite, running high in gold and silver values. Idle. R. Jose, of Hollister, owner.

The Victor Bonanza Group.—Located in Secs. 30 and 31, T. 13 S., R. 10 W., and Secs. 14, 15, 16, 23, 24, and 25, T. 13 S., R. 9 W., sixteen miles southwest of Dos Palos, and thirty-five miles southeast of Hollister. The cropings show a mineralized belt extending five or six miles, and varying from 100 to 200 feet in width. Native copper and chalcopyrite are found frequently in the cropings. The formation is sandstone and porphyry. The ledge matter is quartz. Practically no development has been done, but the surface indications are good. M. T. Dooling, of Hollister, is president of the company.

SAN BENITO COUNTY.

Lewis Creek Claim.—The property is located on Lewis Creek, the southern boundary of San Benito County. It is sixteen miles from King City, on the Southern Pacific Railroad, and in Secs. 2, 3, and 4, T. 19 S., R. 10 W. The development

consists of a 100-foot tunnel, which was intended to tap the ledge, but missed it. Nothing could be learned further than what could be determined from the croppings. The croppings may be traced for four miles. The ore is chiefly chalcopyrite. The formation is sandstone and serpentine. G. W. Spencer, of Hollister, and F. W. Saffel, of Lonoak, owners.

SAN LUIS OBISPO COUNTY.

Los Osos Mine.—Located eight miles southwest of San Luis Obispo, and on the south side of Los Osos Valley. The mine was worked forty years ago, and the ore hauled by wagon to Port Harford and shipped to Swansea. Recently 15 tons were shipped to San Francisco, and gave a fair profit. There is a good wagon road from the mines to San Luis Obispo. The ore occurs in a porphyritic vein in sandstone and shales. A shaft 230 feet deep was sunk on the ledge, a tunnel 235 feet long was run to the bottom of the shaft, and good ore was found in the shaft and the tunnel. The works were not properly protected and were allowed to cave in, consequently all observations had to be made from the surface. Estate of J. M. Gleaves, San Francisco, owner.

Tiptop Claim.—Located ten miles north of San Luis Obispo and three miles southwest of Santa Margarita, a station on the Southern Pacific Railroad. There is a ledge 14 inches wide, carrying native copper. The country rock is shale and serpentine. No development has been done. A. Guillemin, of Santa Margarita, owner.

On the same ledge is the Gloria and the Tassajara mines, similar to the Tiptop, and owned by Mrs. R. Childs and F. Flores, of San Luis Obispo. No development work has been done.

Prodigal Son.—Six miles east of Cayucos, between Toro and Old creeks, and twenty-two miles west of San Luis Obispo. The development consists of a 50-foot shaft on the ledge and 100 feet of tunneling intended to tap the ledge 130 feet below the

collar of the shaft. At the time of visit, the tunnel had not intersected the ledge. The ledge is apparently about 7 feet wide, carrying chalcopyrite, gold, and silver. The gangue is quartz. The formation is syenite and serpentine. E. P. Loring, of Cayucos, owner.

Sky Scraper.—Located seven miles east of Cayucos, on upper Toro Creek, and about twenty miles west of San Luis Obispo. The development consists of two tunnels, cross-cutting the vein, one 250 feet and the other 103 feet long. Where the tunnels tap the vein the ledge appears to be about 10 feet wide. The ledge is porphyry, the formation granite, and the ore chalcopyrite. William Drought, of Cayucos, owner.

Schneider & McCles Claim.—On San Bernardo Creek, seven miles east of Morro. The owners had just begun to develop and had not encountered the ledge in the tunnel. Eight men were employed developing. Schneider & McCles, of Morro, owners.

Refugio Claim.—Located on Chorro Creek, about seven miles north of San Luis Obispo, on the west side of the mountain. The development consists of a 135-foot tunnel. A 4-foot ledge, carrying native copper and sulphide ore, was encountered. The formation is granite and serpentine. Idle at present. Mrs. R. Childs and F. Flores, of San Luis Obispo, owners.

Guerro Claim.—Located one-quarter mile north of Serrano station and six miles from San Luis Obispo. The ledge is in serpentine and shows copper in the croppings. No development has been done. Mrs. R. Childs and F. Flores, of San Luis Obispo, owners.

Guadalupe Claim.—Located one and a half miles from Serrano station and six miles from San Luis Obispo. The croppings show a ledge of quartz 2 feet wide in serpentine. No development has been done. Mrs. R. Childs and F. Flores, of San Luis Obispo, owners.

THE SIERRA NEVADA BELT.

The Sierra Nevada Mountain range contains copper deposits in wider distribution and probably in greater total quantity than any of the other general geographical divisions of California by which the copper resources of the State have been classified. Copper ores have been found practically throughout the length and breadth of the range, which runs for about 500 miles through the eastern side of the State, with a width of from 50 to 75 miles. The deposits are mainly concentrated along a mineral belt which appears high in the range to the north, sweeps southwestward toward the central valley of the State, and then continues for about 300 miles southeasterly through the western foothills, to disappear in Kern County near the southern end of the range.

Here is a definite copper belt approximately 400 miles long. From Nevada County southward it is known as the Foothill Belt, and with it the history of the copper industry of California up to 1896 is mainly associated. The other copper deposits of the range occur, with wide intervals, along both slopes, mainly in the base-ore mineral regions of the higher portions of the range on both sides of the summit line, and especially on the eastern slope in Mono and Inyo counties. The copper deposits of these two counties on the eastern side of the range, in the Great Basin, are grouped with those of the general arid region of southeastern California. The few deposits along the higher western slope are little known and slightly explored. They carry also the precious and baser metals, and some surface prospects at high altitudes indicate ore bodies of possible future value. Throughout the base-ore belt of the high Sierras, which mining enterprise has not yet reached, and which has yet been but very slightly prospected, copper will probably be frequently found in the mineralized zones. Along the middle slope are here and there copper-bearing prospects worthy of incidental note.

Interest, however, is here centered in the belt along the

western flank of the range, in which are the important developed copper mines of the State outside of Shasta County, and which holds much of the industry's promise for the future. It is an important feature of the gold as well as the copper resources of the State. The Foothill Mineral Belt, as generally recognized, stretches from northern Nevada County for about 250 miles southward into Tulare County. For about this distance it has a continuity and a regularity of course that easily establish its identity, and from either end it may be somewhat vaguely traced farther by a series of occasional mineral deposits. There is but a general warrant of convenience for regarding the belt as prolonged northeasterly into the higher slope and for conceiving the 400-mile string of copper deposits of this slope as constituting one copper belt. So regarded, this belt exhibits a definite beginning at the north by the southern edge of the lava sheet that covers so many thousand square miles of the mountainous northeastern part of the State. Such a definite beginning is found on the southern slope of the Diamond Mountain range along the northern border of Plumas County, over 100 miles south of the Oregon boundary. In this region are bunched, in three or four townships, some of the large and probably important deposits of the belt. This is about 75 miles southeast of the eastern end of the Shasta County copper belt, and this intervening space is buried by the lavas which hide all mineral formations except where they are revealed occasionally by erosion. Half way on the direct line between these points is the extinct volcanic peak of Lassen Butte. It is likely that copper-bearing ores underlie this volcanic blanket, connecting the deposits of the Sierra slope with those of Shasta and Siskiyou counties to the northwest, and making one great copper belt reaching for about 600 miles through the eastern and north-central parts of the State into Oregon.

North of the Plumas County boundary, in southern Lassen County, there have been found slight occurrences of copper minerals, mainly as float, but no deposits worthy of note have been revealed in this much-disturbed and lava-buried region. Farther north in eastern Modoc County, in the Warner range of mountains belonging to the Great Basin, there are similar slight indications of copper deposits, but they do not belong to the Sierra belt.

The groups of deposits in northern Plumas County comprise the important discovered ones of the large northern section of the belt above the terminus of the recognized Foothill Belt in Nevada County. In the regions of Indian and Genesee valleys are extensive gossan-capped vein formations, carrying copper, gold, and silver, and some of them considerably prospected. They are in the Sierra gold belt and adjacent to producing gold districts. All carry sulphides at a little depth. Distance from railroads has been a severe handicap to their development. A small smelter which operated for a short time on surface oxides and carbonates was built here in an early day, and a little rich ore has since been shipped. For perhaps 50 miles southward through Plumas and then westerly through Sierra County occasional occurrences mark the course of the belt into western Nevada County, where the foothill series of deposits begins.

From this point southward the Foothill Belt exists as a great fissure system along the base of the range. Its northern end is about 25 miles north of the northern terminus of the Mother Lode in El Dorado County, and it parallels that great lode throughout its length of 125 miles, running from 5 to 20 miles to its west, with an average distance of about 12 miles. The belt runs through the lower western ends of the counties of the slope, but a few miles east of the floor of the valley and through the principal agricultural and horticultural portions of these counties. The climate is that of the populous portion of the central interior of the State. The croppings of the mineral deposits of the belt range in altitude from 300 to 500 feet in Nevada and Placer counties to several hundred, or, in places, 2000 feet in the counties to the southward, reaching still higher altitudes toward the southern end of the belt. The belt is paralleled at 20 to 30 miles by two main railroad lines running through the eastern side of the valley, and it is reached or crossed by several branch lines at different points along its course. Conditions are in general exceptionally favorable to the mining industry.

The belt is quite regularly and continuously traced by surface gossan formations, and thousands of mining claims have been taken up along it, chiefly in early days. A large portion of it, especially in the northern and central parts, is included in patented agricultural lands. Hundreds of mining properties

are now held as such, and a number of valuable mines, productive, idle, or in course of development, are strung throughout its course along the base of the slope. From one end to the other copper deposits occur at frequent intervals.

PLUMAS AND SIERRA COUNTIES.

That section of the great copper belt of the Sierras that lies high along the middle slope courses for about 70 miles southward across Plumas and Sierra counties to then turn westward through Nevada County to the lower foothills. At the very northern end of the belt, in upper Plumas County, are some of the notable unworked copper deposits of the State, and this county's copper resources have received attention since early mining days.

Besides presenting a mineralized copper-bearing belt of similar nature and course, these counties have so much in common in the way of geographical, topographical, and geological features that they may be appropriately taken together here. Both lie in the heart of the Sierras, reaching from the Nevada state line across the crest of the range, and finding their western boundaries high above the foothills that are embraced in all the other mountain counties traversed by this belt. Plumas has a length of 75 miles east and west and an extreme width of 50 miles. Sierra is a much smaller county. The lowest altitude in either county is about 2000 feet, and the main mineral districts lie between 4000 and 7000 feet above the sea. About this region rise some of the higher peaks of the range, and both counties present the rugged surface and scenic grandeur, as well as the abundant forests, streams, and lakes common to the higher slope. Plumas is wholly drained by the Feather River, and Sierra by the Feather and Yuba and their tributaries, and these streams have cut precipitous cañons often 2000 feet deep. A wealth of water power is thus available. Minor portions of the areas of these counties are occupied by small fertile valleys, chiefly in Plumas County. It is in and about Indian and Genesee

valleys in northern Plumas County that the main copper deposits are grouped.

Plumas and Sierra are almost exclusively mining counties, and their copper deposits are in the midst of large and promising quartz mining districts. The great auriferous slate belt of the Sierras crosses both counties north and south, presenting a series of quartz veins through a zone in places more than 20 miles wide. The copper belt is characteristically along the western side of the zone, and runs southward through the middle of Plumas County and the western end of Sierra. Both counties have, since early days, been among the great gold-mining counties of the State. Their early placers were very rich and both have shared with Nevada County the past glory and prosperity of hydraulic mining on this slope and the rich rewards of drift mining, since both extensively share the vast auriferous gravels of the system of "dead rivers" of Tertiary time. While both counties have varied mineral riches, gold has been practically the sole mineral product to date. Coal, copper, marble, iron, asbestos, etc., await more favorable economic conditions. One unfavorable condition, especially in Plumas County, is distance from railroad facilities. Both are inviting fields for mining enterprise.

Plumas County is entered from Lassen County at the north over the crest of the Diamond Mountain range, and from this point there is a rapid descent of 3000 feet in 12 miles, through Lights Cañon, to the north arm of Indian Valley. Along either side of Lights Cañon, a few miles south of the county boundary, are groups of copper claims with promising surface indications, which are strengthened by the indications afforded by numerous shafts, tunnels, and cuts reaching to no great depth. From two groups of claims a little ore has been shipped in past years. Lights Cañon opens on the south into Indian Valley, across which, in the region of Taylorville, are other promising copper prospects, slightly developed. Stretching for several miles east of Taylorville into Genesee Valley and its inclosing hills are the prospects comprised in the Genesee district. One of these, formerly the Cosmopolitan, and now the Reward, was discovered in 1862, and in 1863-4, during the copper boom of that period, was equipped with a small open-hearth smelting plant at a cost of \$30,000. A few tons of matte were produced and shipped, but, as the surface

carbonates and oxides were succeeded at a little depth by sulphides, the process and plant soon proved a failure. The rest of the story of progress is one of claim-holding for forty years, with occasional spurts of small development operations. Within two years considerable development work has been done in a number of properties. In many instances the vein formations in which the ores occur are wide and strong and copper ores of high grade are found carrying good values in gold and silver. The courses of the copper-bearing veins are frequently marked by gossan cappings. The contiguous districts thus described are embraced in an area about 10 miles wide and 15 miles long from north to south, in north-central Plumas County, and only minor occurrences mark the copper belt southward through Plumas and Sierra to Nevada County. There are sporadic deposits east and west of this belt, including northwest Plumas County on a line with the Shasta County belt, but the mineral resources of western Plumas are mainly buried by the great lava sheet, near the edge of which are the chief districts described.

PLUMAS COUNTY DEPOSITS.

Montgomery Group.—About one mile south of Taylorville is the Pettinger mine. Owners, J. D. Williams et al. In this mine the ores are mainly carbonate, with some sulphide. The openings consist of a shaft 60 feet deep, with southerly drift 100 feet long. The vein formation is 6 feet wide. There is some good carbonate ore on the dump. A tunnel 30 feet long, higher up the gulch, shows a vein several feet in thickness and the same class of ore. Other claims higher up the mountain have open cuts on them, which are noticeable mainly because they show heavy gossan cappings. There is also exposed on this mountain a very heavy and almost pure deposit of pyrites, about 40 feet wide, containing a small percentage of copper.

Polar Star.—To the north from the highway leading from Taylorville to Flornoy's and up the mountain is the Polar Star mine, owned by Messrs. Cox, Keasy, and Cooksey, and now controlled by J. D. Williams. This mine is five miles southeast from Taylorville. It is opened by a tunnel and an open cut. The tunnel passes through the vein, which is 10

feet thick, and runs some distance ahead in the east wall. The cut is in a body, or vein, of good ore, of which 50 or 60 tons are on the dump, besides about 10 tons of good ore left from former selections of shipping ore. The ore is peacock, sulphide and carbonate of copper, with considerable red oxide in seams and bunches. The mountain and adjacent country are heavily timbered with pine and fir. Water is plentiful. Idle.

Blue Bell Mining Co.—Along the road toward Genesee, about a mile beyond Hosslekuss's, a limestone belt passes through the country in a northeast and southwest direction. At the apex of a hill on this belt are some heavy croppings, to get under which the Blue Bell Mining Company, J. J. Sullivan, superintendent, are now running a tunnel calculated to be 1000 feet long. This tunnel has intersected thus far seven veins of importance. Development in progress.

Reward, formerly Cosmopolitan.—Belonging to the Reward and Beckwith group; Messrs. Salinger, Emerick, and Rosenthal, owners. Adjoins the Blue Bell group on the east. The vein is intersected by a tunnel 100 feet below the surface, which is exposed 2 to 6 feet in width. Two tunnels tap the ore body. The upper one is 175 feet long, and the lower one, 900 feet long, reaches a depth of 400 feet below croppings. A shaft 125 feet deep (caved) is on the higher portion of the claim. There are about 100 tons of ore on the dump. It appears to be of good grade. The veins lie between granodiorite on the east and limestone on the west. In 1863-4 there was an old smelter at Coppertown, near Hosslekuss's, in which was smelted several hundred tons of ore from the Cosmopolitan. The product was subsequently sent to Swansea. At the site of this smelter there still remain about 75 tons of ore, such as was then smelted. The facilities for opening up both of the above properties, viz: Blue Bell and Reward groups, are excellent.

F. B. Hosslekuss owns and works a claim near by, on Ward Creek, that carries copper and gold.

Duncan Group.—Thirty-three claims, owned by J. D. Williams, are about one and a half miles to the north of Flournoys. The mineralized diorite and diabase belt that passes through this section is about 3600 feet wide. The richer

bunches of mineral, constituting the ores of the district, occur in kidneys, or lenticular-shaped masses in diabase. The principal development work performed on these claims consists of a tunnel 125 feet long, with cross-cut at its end, which cut several stringers and veins of copper-bearing rocks. The mineral-bearing belt is a dike, which consists principally of diabase charged with sulphides of iron and copper. In places, there are gossan cappings, and in others there are cappings of pure magnetite, or black oxide of iron. That in open cuts can plainly be seen to overlie ore carrying pyrites and chalcopyrites. The magnetite has a thickness of 3 to 4 feet. There is an open cut on the hillside above the above mentioned tunnel, where this condition of capping is very markedly shown, and from whence, under the magnetite capping, ore containing red oxide of copper in considerable quantity has been extracted. There is an abundance of croppings of mineralized veins included in the group, indicating that the belt is of large extent. The ore, besides its copper, also carries good value in gold; native gold in the green carbonate and sulphide ore is plainly visible. This is particularly true of the ore in the claim called the Copper King. In the Copper King there is an inclined shaft 75 feet deep, all in ore. The ore at the bottom is known to be 6 feet in width, with no walls. Reported values are \$6 in gold and 9 per cent copper. The ores of the veins of the Duncan group have the same appearance. Grano-diorite or granite forms the east wall, and mineralized diabase the vein filling. The ledges dip to the east. Developing.

Little Gem Claim.—Located on Ward Creek, where there is a ledge opened by a shaft. The vein is from 6 to 18 inches in width, and carries reported values of \$17.96 gold and 31 ounces silver to the ton, and 12.66 per cent in copper. Idle.

Williams Group.—To the west of Flournoy's, about one half mile, is a mountain which is covered by mining locations held by J. D. Williams. On this mountain the whole outcrop appears to be heavily mineralized by iron and copper in the form of oxides, carbonates, and sulphides. So little development work has been performed that no estimate of the worth of the claims can at the present time be made. It is doubtless the outcrop of an immense mineralized dike. Developing.



COPPER CROPPINGS, WILLIAMS CLAIMS, GENESEE, PLUMAS COUNTY.



MOUNTAIN ON WHICH IS LOCATED THE DUNCAN GROUP OF COPPER MINES,
GENESEE, PLUMAS COUNTY, NEAR FLOURNOYS.

In Cook's Cañon, south of Moonlight Creek, are two claims, owned by Frank and George Davis, on which there has been little development. The vein is 12 to 13 feet wide, and shows carbonate and sulphide ores of good appearance. It has been explored for 800 feet in length by cuts. Developing.

Engle Copper Mining Co.—This company, consisting of Messrs. E. V. Spencer, Engle, and Adams, owns two claims on Moonlight Creek, in Lights Cañon, where a tunnel about 100 feet long shows a vein of sulphide, and an open cut exposes the same character of ore. Developing.

W. P. Boyden has a claim on Enterprise Creek, from which he shipped ore reported to have yielded 18 per cent copper and 57 ounces silver to the ton. Developing.

Engle Bros. have two claims on the west side of Lights Cañon, in Sec. 18, T. 27 N., R. 11 E., where a mineralized vein about 30 feet wide, carrying sulphides, is shown. It is opened by a tunnel 120 feet long and a shaft 20 feet deep. Developing.

On the east side of Lights Cañon, above the residence of the Engle Bros., are two claims, Superior No. 1 and Superior No. 2, where openings were made in years past, and ore was extracted and shipped. There are about 50 tons of ore remaining on the dump. There is an open cut 80 feet long, leading into a pit 20 feet wide, by 15 to 20 feet high, with a water-filled shaft in bottom of pit said to be 60 feet deep. From this pit some samples of very good ore were taken. This ore contains a high percentage of zinc. Idle.

Engle Bros. Group.—This group of eight claims is in Secs. 3, 9, and 4, T. 27 N., R. 11 E. The copper deposit is about 300 feet wide and about 1000 feet long. The ores nearer the surface are mostly carbonates, mixed with iron oxide and copper sulphides. The copper belt here is about 1800 feet wide. Reported assays are 10 per cent copper, and from \$2.50 upward in gold. The ore body dips to the west and the strike of the vein is northeast. The openings consist of three tunnels and a shaft. Tunnel No. 1 is 100 feet long, and a cross-cut at the end exposes 13 feet of carbonate ore. The vein on which this tunnel runs is 100 feet wide, and the end of the tunnel is 65 feet below the croppings. Tunnel No. 2 is 325 feet long,

with cross-cut at end which shows a width of 45 feet of sulphide ore 110 feet below the croppings. Tunnel No. 3 (lowest) is 100 feet long, with cross-cut at end showing 87 feet of ore and 20 feet of intermediate vein filling (horse). The ore is carbonate, and is 200 feet below croppings. Open cuts on the surface show ore. Considerable ore has been extracted from these mines and sold. The facilities for mining here are good, and there are exceptional tunnel privileges. Heavy growths of pine and fir on the locations and surrounding country furnish abundant mining timber. Developing.

Hussleman & Shaw Group.—This group, in Moonlight Creek district, Lights Cañon, comprises thirty-one locations, on nearly all of which some development has been done. A tunnel has been started well down on the mountain side, so as to obtain 800 to 1000 feet of depth under the heaviest croppings. This is a cross-cut tunnel and is now in 150 feet. It is intended to continue this 1000 feet farther. The mountain side here is very abrupt. Passing through these claims is also a highly mineralized belt, which contains masses of high-grade ore. Developing.

On the Mammoth claim of the above group the vein trends northeast and southwest. Several open cuts show sulphide ore as well as carbonates. A capping of diorite covers a vein about 8 feet wide, as shown in the largest cut. The capping lies flat and the vein is perpendicular. There is a cross-cut on the vein 10 feet in length, with no wall discovered. A good quality of iron and copper pyrites is shown in face of cut. The same class of ore is traced northerly by cuts for 900 feet. Developing.

On the Orient claim a tunnel has been driven 150 feet. Developing.

On the mountain side and following the course of the proposed tunnel twelve ledges are encountered, all exposed by open cuts. The widest vein is found near the apex of the hill and is about 13 feet wide. It is opened by an extensive cut, and from it ore has been extracted and shipped. The character of the ore is carbonate with some sulphide. The Gentle Annie claim is prospected with open cuts showing a vein 6 to 8 feet in width. The ore is mostly silicious, carrying red oxide, carbonates, and pyrites, and can be traced for over 800

feet. Claims Nos. 1 and 2 have a shaft 13 feet deep, showing peacock copper ore in the bottom. Near by is a belt exposing on the surface iron oxides. The width of the copper vein is unknown. Assays from these claims are reported as showing from 10 to 60 per cent copper.

On the Oregon claim at the east end there is a shaft 13 feet deep, all in green and blue stained ore, said to contain 20 per cent of copper and rich in gold. Some copper glance is also visible in this ore. There are three cuts on this vein, besides a shaft, all showing same varieties of ore. The strike of the vein is south of west. The north wall is diabase, the south diorite. The west end of the Oregon is opened by a superficial cut, which discloses some good carbonate and silicious ore that is reported to assay 48 per cent copper and \$14 in gold, with 15 ounces of silver. A vein parallel with the main one just described also shows good ore. The veins are wide, but the width, owing to lack of development, can not be determined.

On the Olympian claim a vein outcrops and is exposed 30 feet in width of carbonate ore, in an open cut. Lower down the hillside a tunnel was started to obtain 50 feet of backs under the croppings. The tunnel is 85 feet long and cuts 30 feet of gray carbonate ore. The inclosing rock is a diabase, spotted with coarse crystals of feldspar. On the No Wonder claim at the apex of the hill above the Orient tunnel is a vein of green carbonate ore 8 feet wide. There is an open cut 20 feet long and opening on the vein. There are about 100 tons of ore on the dump. In this ore can be seen some copper glance. Developing.

On the south hillside is the Palisades tunnel, which was driven to cut a ledge which crops 12 feet in width above it. This tunnel has a length of 197 feet, but has not reached the ledge aimed at, although it has cut several small veins. On the Iowa claim there are bold croppings carrying some copper and said to be very good in gold values.

The Hussleman & Shaw group is owned by Messrs. Hussleman, Shaw, McIntosh, and Williams, and consists of thirty-one mining claims.

The Mammoth claim is owned by Messrs. Hussleman & Shaw, and comprises twenty-nine mining locations.

Broadly, it may be stated, that iron predominates in both

the Moonlight district and the Genesee district mineral deposits. Accompanying this pervading iron are copper, gold, and silver.

In Sec. 28, T. 26 N., R. 8 E., unsurveyed land, two and a half miles south of Meadow View, on the south face of the mountain facing the North Fork of Feather River, there occurs a deposit of sulphide carrying some copper of unknown value and extent. Two tunnels have been started, one above the other. The upper tunnel does not reach the deposit or vein, and discloses nothing. The lower one reaches the sulphide ore. A caved-in shaft higher up on the hill was sunk years ago.

Still farther south, just below the Bamboo Bridge, is a formation, copper stained, which may prove to be the outcrop of a deposit of iron sulphides carrying copper.

A few minor copper deposits have been noted in the northwestern part of the county, and there are a few other localities where copper-stained rocks are known to exist, as near Mohawk, and in Sec. 16, T. 23 N., R. 11 E., but none of these occurrences have assumed importance.

SIERRA COUNTY DEPOSITS.

In the Poker Flat district, in T. 21 N., R. 10 E., John B. Lassiad owns a claim showing a copper deposit about 60 feet wide, carrying pyrites, oxides and carbonate of copper. The development has been slight.

Bassett's Pride Claim.—About five miles east of Sierra City. Some native copper shows in the deposit, in which a tunnel has been driven. This mine is in Sec. 12, T. 20 N., R. 12 E., and is owned by Albert Church et al.

Near Sierra City, in Sec. 19, T. 20 N., R. 12 E., east of Whitney Camp and northwest of the Buttes Rock, there is a copper mine owned by George Zuver. There is a shaft 40 feet deep from which copper sulphides have been extracted and shipped.

The Antelope Neck mines, in Sec. 27, T. 21 N., R. 15 E., show a wide vein of copper sulphide. Small development. — Beamer is the owner.

In Mohawk Valley near the Bullion claim is a prospect showing veins 15 feet in width, carrying oxide, sulphide, and carbonate ores of copper. The owners are J. H. Hapgood and J. J. Miller.

NEVADA COUNTY.

Nevada, the banner gold-producing county of the State, with a record of about \$215,000,000 in total output of this precious metal, presents some noteworthy copper deposits among the various minor features of its mineral wealth. This county, which still leads in gold production, is so prominently identified with the history of gold mining in California that it is more familiar to the mining world than any of its sister mining counties. Quartz mining in California began in Nevada County in 1850, and here was the origin of hydraulic and drift mining. The copper mine at Spenceville, which has been a small producer through many years, gives it a somewhat prominent identification with the story of the copper industry in the State.

This county comprises a narrow strip of mountain and foothill reaching across the Sierras 75 miles to the edge of the Sacramento Valley, where the altitude is but about 400 feet. Its central and eastern parts are characteristically Sierran. The higher lakes and the Bear and Yuba rivers, between which the county mainly lies, afford, in connection with many tributary streams and with great systems of canals and ditches aggregating hundreds of miles, a copious and well-distributed water-supply. Electric power is also extensively generated and distributed. The Central Pacific Railroad runs along its southern boundary and a branch line runs to Grass Valley and Nevada City, affording convenient transportation to a rich and well-populated mining and horticultural region that enjoys a splendid climate.

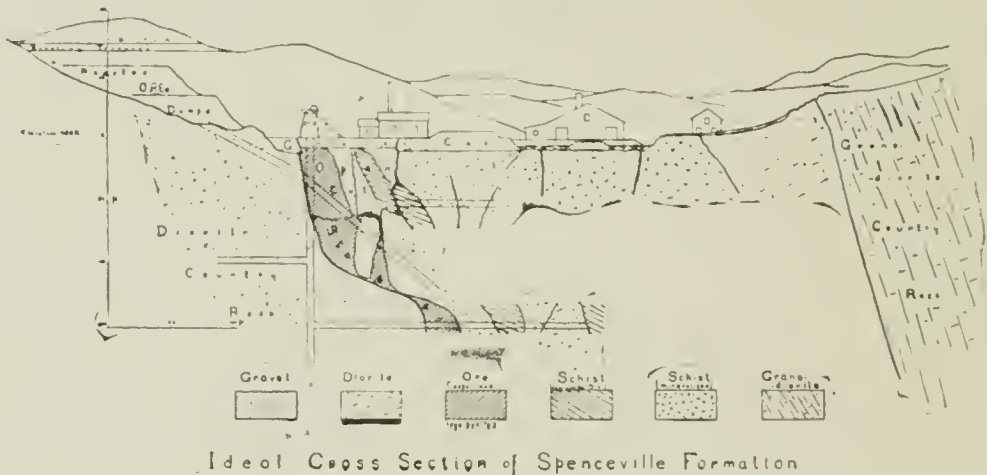
The county's mineral resources are chiefly near its lower western end. Here, about 15 miles from its western boundary, are the remarkable and famous gold quartz districts of Grass Valley and Nevada City. Through this region and extending

to the central part are displayed the ancient river channels which have afforded such extensive hydraulic and drift mining operations, and over the same area are distributed the minor quartz mines of the county, which is traversed by three main auriferous belts. A little west of the Grass Valley gold belt an iron belt crosses the county, and west of this comes the copper belt. From Sierra County it swings southwesterly along the northwestern boundary of the county for perhaps 25 miles, and then turns southward with the direct western boundary line, which it parallels at a distance of from two to four miles along an eighteen-mile course into Placer County. Along the entire course of the belt copper indications occur at intervals, but the chief known deposits are at two points—at Spenceville in the southwestern corner of the county, and about Mineral Hill, three miles to the north, where various properties exhibiting strong veins are being actively prospected, and from where shipments of ore have been made at various times. There are here many strong copper-bearing veins, and the somewhat extensive developments that have been made give promise of profitable and long-continued copper mining here, under favorable market conditions. The mine at Spenceville has produced nearly a million dollars' worth of copper, iron pyrites, and mineral paint, and from above a depth of 150 feet. The developed ore bodies are now exhausted, but search for new ore bodies is proceeding in the same mineralized formation.

Spenceville Copper Mine.—This old property has experienced a longer period of operations than any other copper mine in the State, having been worked almost continuously since 1875. Although its operations have never been on a very large scale, the total product to date being about 150,000 tons of ore, yielding gross returns of several hundred thousand dollars, both the mine and its history have some features of special interest. The mine has produced quite a large amount of copper, and it was the first mine in the State whose product of pyrites was used for the manufacture of both mineral paint and sulphuric acid. It has been the scene of a number of metallurgical experiments.

It is located in the town of Spenceville, in the southwestern corner of the county, at an altitude of 450 feet, and is now owned and operated by the Spence Mineral Company of San

Francisco. The ore occurs in a series of wide irregular fissures near the contact of two large areas of country rock (diorite and grano-diorite), the fissures being filled with sulphide ores carrying copper, gold, and silver. Mining has been confined almost entirely to that ore, which occurred in the main foot wall fissure in the form of chalcopyrite and iron pyrite, being a continuous vein 300 feet long, and 15 to 55 feet wide. The mine has been worked to a depth of 150 feet, from which level it still continues in depth. This vein yielded 150,000 tons of ore, the copper content varying from 2 to 20 per cent, the greater part averaging about 5 per cent. By the crude method of roasting and leaching only about 4 per cent of this ore, or 6000 tons, was recovered as copper, the gold and silver, which averaged from \$3.50 to \$4.50 per ton, being lost.



Ideal Cross Section of Spenceville Formation

Parallel and cross fissures on the hanging-wall side of this main ledge are filled with strongly mineralized schists and altered diabase, too low in sulphur to be burned and requiring a different method of treatment, but indicating a wide area of mineralization having possibilities in depth.

The San Francisco Copper Company pursued active operations for thirteen years succeeding 1875. The mine was opened by shafts and drifts to about 150 feet in depth, and then, after the works had caved in, mining was pursued in an open cut which became 300 feet long, 70 feet wide, and 75 feet deep. Most of the ore taken from the mine, approximately 150,000 tons, carrying an average of 5 per cent of copper, was extracted by this company prior to cessation of operations in 1888, and the sale of the property in 1890, owing to the fall in the price of copper. This company made some costly and

unsuccessful smelting experiments and produced some matte and ingot copper. Most of the output, however, was cement copper, produced by heap roasting and leaching, this company being among the first in this country to introduce and successfully operate by this method. During the year 1882 the company mined over 16,000 tons of ore averaging 4 per cent in copper, and 966,061 pounds of cement averaging 83 per cent in copper, which was shipped to Boston. There was roasted 12,300 tons of ore, yielding a net profit of \$2 per ton at current



PLANT OF THE SPENCE MINERAL COMPANY, SPENCEVILLE.

prices. During the year 1882 the cost of production was 9.4 cents per pound of fine copper. The water from the mine workings was also run through precipitating sluices. The price of copper cement fell in 1887, and operations ceased.

In 1890 the Imperial Paint and Copper Company acquired the property for the purpose of utilizing the old dumps of roasted ore. They erected a paint mill and calcining furnace and manufactured red metallic paint from the iron oxide, which constitutes approximately 40 per cent of these dumps. They also leached the dumps and utilized the mine waters in

making cement copper. They did no mining. The paint manufactured was of exceptional quality, and had a ready sale at the market price of standard paints.

In 1897, the Spence Mineral Company acquired the property and introduced into California a new method of manufacturing sulphuric acid by substituting pyrites as a source of sulphur for the crude sulphur imported from Japan. This proved thoroughly successful and has revolutionized the methods of acid-making on this Coast. The mine was unwatered and re-opened and large bodies of low-grade pyrites left in the old works were shipped to manufacturers of acid on the bay of San Francisco at a good profit, the cinders being returnable to the company. These ores proved to be well adapted to this purpose, owing to the absence of arsenic and other injurious elements, and to their free-burning quality, yielding up their 45 to 50 per cent of sulphur without the least tendency to clinker, and retaining the smallest percentage of sulphur in their cinders.

The copper contained in these cinders, amounting to from 3 to 3½ per cent, together with the gold and silver, and the iron which has a value as a flux, netted the company from \$2 to \$3 per ton when subsequently sold to smelters. A successful leaching plant has been constructed by the company on the bay of San Francisco, where its cinders are leached and cement copper manufactured.

At the present writing the company has under way the thorough development and exploitation of its mine below the 150-foot level, and throughout its mineralized area above described, and has under consideration the future treatment of its ores by more modern and efficient methods. Charles W. Howard, Spenceville, is general manager and superintendent.

Between Spenceville and the Placer County line to the south there are several prospect holes sunk on the mineral belt, showing the same character of copper mineralization as at Spenceville. On the Nickerson ranch, in Sec. 29, T. 14 N., R. 8 E., by Wolf Creek, there are exposed two large ledges carrying almost pure pyrites and some gold. Tests of ore from dumps show a copper content of 4 per cent. There is a cross-cut tunnel 200 feet in length, which taps the ledge.

Croppings are visible for about 800 feet along the ledge. Very little development, however, has been done. The owner is J. R. Nickerson, residing on the property.

Many of the prospect holes above mentioned were made in early days, since which time the lands have been patented and prospecting stopped. This is true also of the territory lying north of Spenceville.

At the Henry Hibber mine, in Sec. 32, T. 14 N., R. 7 E., seven and a half miles southeast from Spenceville, there are croppings of gossan 3 feet wide and over 400 feet in length. The vein here dips west. The east wall is diorite; the west, schistose diabase. When inspected the owner had reached copper ore in a vein 2 feet wide, carrying from 9 to 41 per cent of copper, with some gold. The Bear River runs through the property. Idle.

Mineral Hill Mines.—About two miles north of Spenceville is located the Mineral Hill group of mines, which are now being quite actively prospected. The Mineral Hill Mining and Smelting Company, of which C. C. Bitner is superintendent, owns five claims on the copper belt lying in Sec. 13, T. 15 N., R. 6 E.—the Golden Eagle, Index, Legion, Mineral Hill, and Progress. The California Gold and Copper Company, C. C. Bitner, superintendent, owns six claims—the Jackson, San Francisco, American, St. Louis, Philadelphia, and Sixteen-to-One. The Sacramento, Main Chance, First Chance, and Advance Chance are owned by C. C. Bitner. The Arkansaw Traveler is owned by Jackson & Monasco. The Last Chance, a patented mine, is owned by F. Miller and E. A. Roberts of Sacramento. The Green Lead is owned by the heirs of Thomas Mooney, residing in Smartsville, Yuba County. The Monmouth and Climax claims are owned by J. F. Dempsey of Smartsville.

Bitner & Austin were running a cross-cut tunnel through the Advance Chance, First Chance, Main Chance, and Sacramento claims easterly from the ravine, expecting to intersect thirteen ledges with this tunnel, as that number outcrop on the hillside. They expect to finally strike a very wide ledge, the main croppings of which, about 100 feet wide, are near the summit of the hill. The course of this vein is east of north. The thirteen parallel veins vary from 5 to 30 feet in width on

The Golden Eagle is opened by a shaft 15 feet deep, showing a 4-foot vein of sulphide of copper and iron. At the north end line, on a vein west of and parallel with the Last Chance vein, is a shaft, inclined to the east, 150 feet deep. To the east of these veins is a tunnel 70 feet long, driven on another vein 300 feet, and at its end is a cross-cut to the west ledge. This vein carries the same apparent variety and grade of ore, having some gold content. A considerable amount of carbonate ore shipped from this mine is said to have had a value of \$12.50 gold per ton and 10 per cent of copper.

In the Sixteen-to-One mine, a shaft is now being sunk in a 20-foot vein. At the time of inspection it was 30 feet deep, all in ore. The ore appears to be of the same general character as in the other mines of the Mineral Hill group, is in quartz and diabase gangue matter, and carries from 7 to 14 per cent of copper.

In the Jackson mine, the improvements consist of a 450-foot tunnel on the ledge, started near the south end of the claim. A body of ore was passed through near the mouth of the tunnel. Most of this ore body was extracted and shipped. It is said to have yielded 8 per cent of copper and \$10 in gold. The vein is from 6 inches to 7 feet in width. There are croppings beyond the breast of tunnel 60 feet wide. There is also a shaft 50 feet deep, in ore.

The Arkansaw Traveler has a tunnel 12 feet long showing a vein of ore 3 feet wide. Ore yielding 5 per cent of copper and \$7 in gold has been shipped.

The Genevieve has no openings or improvements worth mentioning. Owned by C. C. Bitner and F. B. Verby.

The Progress mine has a shaft 30 feet deep, and shows sulphide ore similar to that of the mines of the district.

The Monmouth and Climax claims have a tunnel 460 feet long intended to tap a ledge, and two shafts, one 30 feet and one 50 feet deep, on different veins about 100 feet apart. The ores are light-colored sulphides, which carry 3 to 4 per cent of copper and some gold.

There are gossan outcrops in various places on Mineral Hill, especially on the south end of the Advance and First Chance claims. All ore shoots pitch to the north. All the veins passing through the hill appear to belong to a lode lying to

the east of the Spenceville lodes. C. C. Bitner produced and marketed cement copper in 1880 from the Golden Eagle ores.

The California Gold and Copper Company is now running a long tunnel to obtain several hundred feet of backs in its claims.

The Mineral Hill Mining and Smelting Company is also running a deep tunnel to obtain 500 feet of depth under the best of its claims. This tunnel has already cut three very promising ledges.

The facilities for working any group of the above mines are excellent. An abundance of heavy pine timber stands on the claims, and covers the adjoining country. The abruptness of the hills makes tunnel mining possible for many years to come. Water for power could be obtained from the Excelsior Water Company, one of whose ditches passes along the top of the hill.

Ledges of copper-bearing rocks not greatly prospected appear in places along the belt to the north county line at Yuba River. From the Green Lead going north, the belt appears to swing to the east and passes through the east half of Sec. 1, T. 15 N., R. 6 E., and Sec. 6, T. 15 N., R. 7 E., by the old Hartley house. It thence makes to the north through Sec. 31, T. 16 N., R. 7 E., and then through Secs. 31 and 19, T. 16 N., R. 7 E., to the Yuba River. There are no extensive workings on this section of the belt; croppings and shallow holes indicate the course of the belt, which follows closely the grano-diorite formation.

On the road from Smartsville to Grass Valley copper croppings may be seen on the Finie ranch and on the Campbell ranch. Croppings occur also one mile south of the J. Fennimore ranch. Here the vein matter is about 40 feet wide, but not prospected.

Toward the south and southeast of Mineral Hill, the copper belt passes through the Bingers ranch, about four miles south of Mineral Hill, where there are strong croppings. Springs on this property are very strongly impregnated with copper.

Near French Corral, in T. 17 N., R. 7 E., there is a large deposit of pyrites carrying chalcopyrites; undeveloped. Daniel Roberts, owner.

Near Sweetland, in T. 17 N., R. 8 E., is an unexplored copper vein.

In Washington Township, Sec. 8, T. 18 N., R. 11 E., is a vein 6 feet wide, carrying copper, but little developed. E. T. Worthley, owner.

Near North Bloomfield, in Sec. 6, T. 18 N., R. 10 E., is a claim called the Edison Copper Mine; Otto Woehler, owner. It is opened by a shaft 45 feet deep, following the vein. The hanging wall is a schistose diabase; the foot wall is serpentine. The vein averages about 13 feet in width in the bottom of the shaft, where some drifting has been done. It is reported to carry $3\frac{1}{2}$ per cent of copper and \$3.25 in gold. There is also a tunnel driven 240 feet. At the face of the tunnel drifts have been run on the vein 25 and 15 feet in length, respectively.

YUBA COUNTY.

To the west of Nevada and also north of its western portion lies the small valley and foothill county of Yuba, which presents a few occurrences of copper ores. These are but a few miles from Nevada County's line of deposits, and may be regarded as belonging to the same belt, flanking it in the manner of so many occurrences that elsewhere mark the varying zone described as the general foothill belt. The principal occurrences are on the Dempsey ranch, five miles north of Spenceville, near the county line, and on the Brady ranch, in the southern portion of the county west of Spenceville and northwest of the chief occurrences in Placer County.

Dempsey Ranch.—Here bold croppings over 400 feet wide, exhibiting gossan croppings, present interesting surface indications of what may be a large copper deposit. Some samples of ore have assayed 35 per cent copper. This prospect is on a productive ranch and has received little intelligent development, the latter consisting of some prospect holes and a tunnel 100 feet long.

Brady Ranch.—On this ranch, in Sec. 1, T. 15 N., R. 5 E., and in Sec. 35, T. 16 N., R. 5 E., croppings occur and there is an old abandoned shaft, the water from which is strongly impregnated with copper. Prospect holes trace the belt southeast to Bear River, through Secs. 21, 22, 27, and 28, T. 14 N., R. 6 E. On the Brady ranch is what is called the Old Red Ledge, wherein red oxide of copper is visible. This deposit was quite extensively exploited in 1863.

PLACER COUNTY.

Placer, one of the tier of rich mining counties which span the Sierra range, lies south of Nevada County, and in its length of 100 miles it reaches from the angle in the State's eastern boundary down into the Sacramento Valley, possessing in its foothills a section of the copper belt. Its physical characteristics are those common to its neighbors of the great range, as were the general features of its early mining period. It shared largely in the prosperity of the period of hydraulic mining through the possession of rich and extensive ancient river channels.

Its drift mines now give it its claim to preëminence in one feature of the mining industry. In the Forest Hill Divide, a great spur of the range, reaching westward down the slope for 25 miles, there lies deeply buried under lava cappings the most extensive network of ancient river channels found along the range, and in this divide are the chief drift mines of the world. This divide has yielded over \$30,000,000, and the bulk of the total current output of the drift mines of the State is yet credited to Placer County.

A little to its south, in El Dorado County, is what is generally taken to be the northern end of the Mother Lode, and a little to its north, in Nevada County, are the famous Grass Valley and Nevada City mining districts. The great Sierra gold belt crosses the county, presenting innumerable and widely distributed quartz veins, and there are many rich mines, but quartz mining is yet in a relatively backward condition. The gold output in 1900 was nearly \$1,000,000. Granite and

pottery are the chief additional features of its mineral industry, in which Placer County holds a leading place. Iron, chrome, manganese, marble, limestone, and mineral waters are among its other mineral resources. Lake Tahoe, at an elevation of over 6000 feet, lumber forests, and a rich horticultural region in the foothills, are among other features of the county. The Central Pacific Railroad traverses the entire length of the county along its northern border.

At various places along an irregular line across the western portion of the county the foothill mineral belt displays copper deposits. A few have been prospected and small amounts of copper ore have been shipped. Some very wide veins are displayed, but Placer County has not yet made copper a prominent feature of its mineral industry.

Algol Mine.—This is one of the copper prospects opened in the early sixties and subsequently abandoned. The present owner has re-opened it within the past three years. It is in Sec. 9, T. 13 N., R. 7 E., a few miles southeast of Spenceville, Nevada County. The vein channel is 50 to 60 feet wide. The more highly mineralized portion constituting the ore is from 20 inches to 10 feet in width, the ore occurring in lenses. The length of ore now forming the shoot is 90 feet. There is one shaft 120 feet deep, with a drift running north 100 feet, and another shaft 120 feet deep, with drifts at the 50- and 100-foot levels. A cross-cut runs from one shaft for 65 feet to the west. The ores are red oxide and blue and green copper minerals, besides considerable native copper in sheets and bunches. Native gold also accompanies this deposit. Ten carloads of ore were shipped to a reduction works, which averaged 20 per cent copper. A horse-whim is used for hoisting, and a boiler and steam-pump raise the moderate daily amount of water. Electric power for mining and reduction purposes can be readily obtained.

On the south of the Algol mine there is a shaft on an extension claim, 80 feet deep. This shows copper ore. Farther to the south, going to Coon Creek, there are five shafts, with depths of about 50 feet each, sunk years ago, and all showing strong copper indications. Farther south, beyond Coon Creek, there is a shaft 40 feet deep, showing some copper. On the Lardner ranch, and on the Keiler ranch, three miles

south of Lardner's, there are also strong croppings of copper-bearing rocks.

Valley View Mine.—This property lies six miles north of Lincoln; patented; 90 acres. The vein matter is 200 feet wide between walls. The ore is 37 feet wide and the walls are a schistose rock. There are three shafts, respectively 90, 100, and 130 feet deep. Between the middle and south shafts most of the development has been done. There is a tunnel 50 feet in ore. Another tunnel, 130 feet long, taps the vein 90 feet below the surface. There are gossan croppings 100 feet wide for over 1000 feet along the vein. This gossan carries in gold and silver from \$1 to \$10 per ton, and is reported to average \$4 per ton. The mine was worked for years for the gold in the gossan. The mine has shipped copper ore averaging about 5 per cent copper. There are two five-foot Huntington mills and various buildings. The owner is the Valley View Mining Company, of San Francisco.

The estate of Charles T. Reed owns 1400 acres of land, on which there is a shaft 25 feet deep, showing indications of copper. This is in the Clipper Gap district. Idle.

North of Auburn, four miles on the road to Grass Valley, there are indications of copper.

Big Pine Mine.—In Sec. 16, T. 12 N., R. 8 E.; J. A. Bouk and C. R. Bushnell, owners. Shaft 170 feet deep, showing chalcopyrite, said to carry 10 to 12 per cent of copper. Idle.

EL DORADO COUNTY.

El Dorado County, the scene of Marshall's discovery of gold and the earliest beginning of the modern era of gold mining, includes, through its lower western portion, along the edge of the Sacramento Valley, about 25 miles of the foothill copper belt. Along this line the belt mentioned displays many copper deposits that have been prospected in the superficial way common to the Sierra Nevada array of these deposits. They are but a little north of the section of the belt through Amador

and Calaveras counties, in which the chief development and production of this copper belt have occurred.

None of the counties of the slope presents more favorable conditions for mining and none offers a wider or more attractive field for mining enterprise. The chief of the mineral belts that cross the county is the Mother Lode, the northern end of which is near the northern boundary and along which, across the county southward, is a succession of valuable and promising quartz mines. Since the exhaustion of the rich surface placers and the cessation of hydraulic mining, quartz mining is the leading feature of the county's mining industry. There are many miles of unprospected ancient river channels. The northern and southern boundaries are formed respectively by the Middle Fork of the American and the Cosumnes River, and these streams, with the South Fork of the American and the many tributary streams, bounteously water the county and afford convenient sources of power. The timber resources are those common to the slope. The western portion of the county has a delightful climate, and the foothill mineral belt runs through a rich and settled region. It is crossed by the branch railroad running to Placerville. While gold remains the mineral product of overshadowing importance, the county has other minerals in large variety. Near Placerville is an eight-mile belt of finely laminated slates, in which several slate quarries have been opened. In 1900, 3500 squares of superior roofing slate were produced, and the industry is increasing the county's prosperity. This is the only county in which slate is commercially produced.

In 1900, 3125 pounds of copper, the product of ore shipments from developing prospects, was credited to El Dorado County. While a number of the best developed copper properties display very wide veins carrying ores that often assay well and continuous gossan cappings of copper-bearing lodes can be traced for miles, no producing mines of importance have been developed. Tunnels and drifts aggregating thousands of feet have been run in the work of prospecting, and several properties have thus been opened sufficiently to indicate values worthy at least of investments necessary for further exploration. Some of the ore bodies carry good values in gold and silver along with good percentages of copper sulphides. The

characteristics of both vein matter and walls display much variety. During the past two years several properties have been undergoing development.

Alabaster Cave Mine.—Located in Secs. 10 and 15, T. 11 N., R. 8 E., seven miles east from Newcastle, Placer County; owner, Holmes Lime Company, of San Francisco. The mine is now bonded to Anderson & Hoagland. The mine is on 180 acres of patented land. The vein can be traced for over six miles. Croppings of gossan are solid for 1200 feet in length, and in places are over 30 feet wide. The hanging wall is limestone; the foot wall, slate. The ledge is very strong and unbroken. The vein matter is partially a mineralized diabase. The ore is oxide and carbonate near the surface; in depth it is sulphide. The ore is said to average 4 per cent copper, with small amounts of gold and silver. On the dump there are about 50 tons of ore said to assay 13 per cent copper. The openings consist of three shafts, one of 300 feet depth and two of 50 feet; they all expose the same character of ore. The pay ore averages 3 to 8 feet in width. The vein matter is 12 to 20 feet between walls. Some native copper appears on the wall rocks in thin sheets. There are two tunnels, one of 100 feet and one of 30 feet. Developing.

Kelley Bros. own a mine on the 560 acres of patented ground in Sec. 11, T. 11 N., R. 8 E., two miles southwest from Pilot Hill, and one and a half miles south from the Alabaster Cave mine. The main vein is 40 feet wide. No capping. There is a network of ledges similar to the White Rock country in Mariposa County. The openings are 2000 feet of drifts and tunnels. The ores carry gold, silver, and copper. One ledge is reported to yield ore assaying 5 to 11 per cent copper.

Lilyama Mine.—In Sec. 3, T. 11 N., R. 9 E.; owners, Robert Crocker & Co., of Placerville. The property consists of 240 acres of patented land. The length of the vein covered by the claim is half a mile; the width, from 600 to 800 feet. Granite forms the east wall, and quartz porphyry the west. Between these lies a band of mineralized limestone, probably pitching to the east. The croppings are gossan and nearly pure black iron oxide (magnetite). The deposits were first

slightly opened in the sixties by cuts and short tunnels, which were driven until they encountered the ironstone. When that was reached the prospectors quit, just before encountering the copper ore, for which they were evidently seeking. The later developments were commenced in August, 1899, and were continued about a year. They consist of four main tunnels and one prospect shaft 20 feet deep. The ores are principally sulphides, but there are also other varieties of copper ore. The ore masses occur in lenses in the limestone. The mine is eleven miles from Auburn, Placer County, connected with that place by a good stage road. There are now 300 tons of ore on the dumps.

Pioneer Mine.—This is an extension of the Lilyama. The vein ore and formation are precisely the same in both mines. It is in Sec. 3, T. 11 N., R. 9 E. The owner is William Haaker. The vein matter is 50 to 60 feet wide. The vein runs the length of the 80 acres of patented ground. It is opened by a main tunnel 900 feet long with two branches, one of 350 feet and another of 200 feet. There are two shafts, one of 90 feet and one of 100 feet, connected at bottom by a drift 50 feet long. These encounter a good body of ore. Idle.

Homestead.—This property, which has been worked for the gold contents of a ledge 14 feet wide, is three miles west of Greenwood at the northern side of the county, and displays ore carrying a considerable percentage of copper. Owner, — McCrary.

Cambrian Mine.—In Sec. 23, T. 11 N., R. 9 E., about ten miles from Placerville. When first opened in the fifties it was for gold, but latterly the good percentage of copper has brought this mineral into prominence. The present owner is the Cambrian Mining and Milling Company, a corporation, of which F. Thomas is president, Leonard Thomas general manager, and D. R. Roberts superintendent. The company took possession in January, 1898. The width of the three veins passing through the property is from 15½ feet down to an average of 6 to 8 feet. The veins are from 50 to 70 feet apart. The vein matter is talcose schist and lime. The east wall is granodiorite, the west serpentine. Between these are bands of schist and limestone. The croppings are talcose schist and

gossans in the schistose rock. All dip to the east. There are three tunnels—one of 113 feet, the second of 220 feet, the third of 1360 feet in length. Also two winzes, each 187 feet below the 1360-foot tunnel. There are over 1350 feet of drifts. The ore is sulphide, green carbonate, red oxide, and native copper, and carries reported values from 8 to 16 per cent copper. The most interesting feature, however, of this ore is the quantity of gold it carries. The company has shipped several carloads of ore as it came from the vein with no assorting, reported to be 10 per cent copper. There are now employed about the place 20 men doing development work.

Cosumnes Copper Mine.—This property lies off the copper belt east of the Mother Lode, in Sec. 25, T. 9 N., R. 12 E., and was opened in very early times. The vein courses east of north and west of south, and is in mineralized limestone and amphibolite schist. The ore is sulphide, green and blue carbonate, oxide, silicate, and peacock, with reported values of over 4 per cent copper. One tunnel, 100 feet long, cuts the vein for 30 feet, and is not yet through to the wall. A winze is sunk in the tunnel 30 feet, all in ore. Another tunnel, 150 feet long, passes westerly through a light-colored diorite rock to the vein, and then turns and follows its course for 60 feet. Another tunnel runs toward the east for 80 feet through the granite hanging wall. The limestone belt is 500 feet wide. There appears to be no iron capping. The sulphides come to the surface in the limestone. Idle.

Wm. Barklege and S. W. Miller own a claim in Sec. 13, T. 12 N., R. 10 E., on 140 acres of patented ground. The croppings show a gossan cap 100 feet wide. A tunnel has been driven 118 feet, and is expected to strike the vein at a depth of 280 feet. Very little development has been done. There are indications of copper. The formation is slate. Idle.

Contraband Tunnel Claim.—Located near Georgetown, in Sec. 24, T. 12 N., R. 10 E. Owner, O. F. Ford. Besides tunnels which show ore carrying copper from a trace to 1 per cent, there is an inclined shaft 40 feet deep, and in this there is an oxidized ore that shows native copper and ore containing 10 to 18 per cent copper. The vein is about 12 feet wide. The hanging wall is micaceous schist. The foot wall is not reached. Idle.



COSUMNES COPPER MINE, EL DORADO COUNTY.



CONTRABAND TUNNEL, EL DORADO COUNTY.

Arizona Claim.—North of the above described tunnel. It has gossan croppings 100 feet wide.

Copper Chief.—Owners, William James and L. A. Beckstead. Lies in T. 12 N., R. 10 E., two miles east of Georgetown. Gossan croppings 100 to 200 feet wide. Walls serpentine. No development.

Agara Claim.—"Big Jim," a Chinese, owner; one half mile north of the Cosumnes mine, in Sec. 19, T. 8 N., R. 9 E. Shaft 25 feet deep. Idle.

Boston Mine.—This is an old mine about four miles west of Shingle Springs, in Sec. 22, T. 9 N., R. 9 E. It has a shaft about 400 feet deep. The owners extracted and shipped good ore up to the seventies. Vein matter, schists; ore, sulphides. Has been idle for many years.

Dr. Wren Claim.—In Sec. 7, T. 9 N., R. 11 E.; east of Cilio's ranch, and east of the Mother Lode. Vein matter talcose schist, foot wall porphyry, hanging wall black slate. Vein, 6 feet wide; shaft, 18 feet deep. Several open cuts. Reported values 5 to 18 per cent copper. Idle.

Robert Claim.—Owned by W. L. and L. Robert, in Sec. 13, T. 9 N., R. 11 E. Vein is $3\frac{1}{2}$ feet wide. Formation slate, with a quartz vein on the east side. Foot wall schist, hanging wall slate. Shaft 80 feet deep and a tunnel 150 feet long, tapping ledge. Copper content reported to be from 4 to 24 per cent. Idle.

There are several holes between Shingle Springs and Latrobe, where former prospectors searched for copper. The developments are, however, so slight that they serve to indicate the presence of copper ore rather than the extent of it.

The Bryant ranch, in Sec. 2, T. 8 N., R. 9 E., one and a half miles northeast from Latrobe. Ledge 4 feet wide; shaft 65 feet deep. Idle since 1860. Ore carbonate and gray oxide copper. Owner, "Big Jim," a Chinese, who also owns a property in Sec. 8, T. 8 N., R. 9 E., five miles north of Copper Hill. Vein 6 inches wide. Tunnel 100 feet. Ore carbonate and gray copper. Idle.

About a mile north of Latrobe a prospect owned by W. W. Woods displays a shaft 12 feet deep in a vein 5 feet wide. Strong iron capping. Vein matter schistose diabase. Ore sulphide and oxides of copper.

Bunker Hill Claim.—In Sec. 14, T. 12 N., R. 9 E., four miles southwest of Greenwood. There is a shaft 60 feet deep. Good ore. Owner, — Terry.

Rip and Tear Mine.—Two miles north of Latrobe. The owner, W. H. Dodson, has 160 acres patented, on which the copper belt appears. There is a shaft 100 feet deep, showing massive pyrite containing copper. Some ore has been shipped. The ores are sulphide, green carbonate, and red oxide. The vein is about 5 feet wide. Still farther north, about one mile, there is on the same property another shaft 40 feet deep. The formation of the latter claim is the same as that of the former. Idle.

Bob Mine.—This is a patented claim, formerly known as the Iron Crown mine. It is owned by S. B. Selkirk and Col. George W. Dent, and is located in Sec. 13, T. 12 N., R. 10 E., one and one quarter miles east of Georgetown. There is a gossan capping from 40 to 300 feet wide. The croppings show distinctly in one place 200 feet in width and can be traced for 800 feet in length. The ledge can be traced for ten miles north and south. One spur on the north end crops 40 feet wide about 400 feet south of the north line. About 1200 feet from the south line Miller & Barklege are running a tunnel to tap the ledge at a depth of 200 feet. Farther south on same belt at the Ford mine considerable work is being done. Beyond the Ford mine only croppings show, no work having been done. There are two locations north of the Bob claim showing strong croppings of copper. No work has been done on them. The developments in the Bob mine consist of one 75-foot shaft, which was sunk on the east wall, and two shallow cuts. The shaft was sunk to reach the ledge at a depth of 100 feet. The water in the shaft carries copper in solution. The vein is between serpentine and slate walls, highly mineralized. The Dark Cañon ditch runs through the claim. From 12 to 15 per cent of copper and \$30 in gold are the reported values in the

Ford mine on the same belt as the Bob mine. In the Bob mine the reported values are \$7 in gold, silver 1.58 oz., besides some copper.

Noonday.—A prospect in the Diamond Springs mining district, in Sec. 18, T. 9 N., R. 11 E., owned by Wrenn & Proctor of Placerville. Shafts, respectively 17 and 28 feet deep, showed a 6-foot vein carrying ore yielding from traces to 10 per cent of copper and about \$3 in gold per ton, with a little silver. Since the mine was visited it has been bonded by the Peyton Chemical Company of San Francisco, which has proceeded with development.

A few tons of copper ore assaying from 15 to 18 per cent, with some gold and silver, have been shipped, during development, from a claim in Sec. 8, T. 13 N., R. 8 E., seven miles north of Auburn, and owned by Peter Oest of Auburn.

AMADOR COUNTY.

Amador County, chiefly famed for its gold mines, holds high rank in copper resources and total output of copper among the counties of the Foothill Belt. It displays copper-bearing formations similar to those of its neighbor on the south, Calaveras County, in which the copper industry of the State began, and in which the most important mines of the copper belt have been developed. In 1861 and the succeeding years of that period, several mines which were opened yielded considerable quantities of shipping ore, but only one has ever been equipped with a reduction plant worthy of note. This is the Newton, which has been one of the leading and well-known copper mines of the belt for a long period, though for a number of years it has been idle or worked on a small scale. It has a smelting plant of small capacity, but the intermittent operations of recent years have been confined to leaching ore-piles, chiefly the old dumps. In 1900 the county was credited with 220,000 pounds of copper cement, the output of the Newton.

This is a comparatively small county, reaching as a narrow

strip from the summit of the Sierra range to the low foothills. In the higher Sierras are splendid forests and many lakes, the latter including the group known as the Blue Lakes, which conserve the water-supply of an extensive canal and ditch system, and also of one of the largest electric power plants of the State. Amador is distinctively a gold-mining county, and one of the leading ones of the State, as its gold output of \$1,373,788 in 1900 testifies. Its fame as a mining county rests mainly on the section of the Mother Lode belt that crosses it. Along this belt are ranged the Kennedy, Argonaut, Zeile, Oneida, Central Eureka, Wildman-Mahoney, Keystone, and other widely known gold quartz mines now in active operation. Here has been the chief scene of the successful re-opening of old quartz mines at great depth, and of the demonstration of the deep values of the Mother Lode. Lignite has been mined in the western portion of the county for many years. Marble and building-stone are quarried, and pottery clay is actively produced. Quite a number of diamonds have been found in auriferous gravels covering volcanic formations near Volcano. A branch railroad reaches Ione in the foothills.

Newton Mine.—This has been the principal copper mine of Amador County during the past forty years and is one of the oldest and most extensively developed mines of the foothill copper belt. It is located at Ranlett, four miles east of Ione, on the stage road to Jackson and Sutter Creek. It was opened in the early sixties and worked quite vigorously prior to 1866. Since then, operations have been intermittent and generally on a small scale. In 1886 it passed to its present owners, the Newton Copper Company, Col. Horace D. Ranlett, of Ranlett, one of the oldest copper operators of the State, president and manager. It was re-opened in 1887, was worked at intervals thereafter, and in 1889 an 80-ton smelter was installed. During 1891 leaching ore for cement was active and still continues. This mine is in one of the lodes that can be traced for several miles through this portion of the county. The gossan-capped vein is from 4 to 8 feet wide, courses east of north, dips 70 degrees to the east, and displays solid lenticular ore bodies, not mingled with the containing rock, as is the case at Copperopolis and mines elsewhere. The property has been opened by two shafts, one 150 and one 430 feet deep, and by 2000 feet of

drifts on four levels, besides winzes and stopes. The richest ores were yielded in the workings at the south end of the mine, from which much ore running 15 to 25 per cent was shipped long ago, and where mining ceased at 300 feet. To the north of the main shaft, where more recent operations have been carried on, the ore is reported to average 7 per cent. The ores are sulphides and carry small gold values. They are well adapted for leaching.

One interesting feature of this mine is the extensive mineralization of the foot wall, composed of sandstone and mineralized slate. It was but recently discovered that here the country rock, to a distance of 15 to 25 feet from the vein, was filled with mineral depositions, mainly sulphurets, carrying 3 to 6 per cent copper and considerable iron. This mineralized mass, which accompanies the vein as far as explored, exhibits partial oxidation to a considerable depth. The material easily disintegrates, and under all the circumstances could be cheaply mined. During recent months, Colonel Ranlett has made some experiments to test the possibility of leaching this material for copper without roasting. It could be so leached, as mined to the degree in which oxidation has occurred, and would respond to successive leachings to the extent of further oxidation in exposed dump piles, as do the piles of roasted ore so treated.

The most recent period of activity at the Newton mine began in 1899, under the stimulus of copper prices. A smelting plant, consisting of one 80-ton water-jacket blast furnace of modern type, was installed and the surface plant generally improved. The hoist is now capable of operating to 1000 feet. During 1900, 3500 tons of 7 per cent ore were mined. After heap-roasting, 3000 tons of the ore were smelted to a 50 per cent matte in a campaign of forty days. Five hundred tons of the newly mined ore remained as fines, and went to join the old dumps for leaching. The matte produced was shipped to Liverpool, paying \$20 per ton railroad charges to New York en route. Since then, custom reduction plants, which include converters, have been established in California, affording a distinct improvement in the conditions encountered by any copper property equipped with a small furnace in which ores can be concentrated to matte. Since this campaign, the smelter has remained idle, through circumstances not involving its

efficiency. During the recent mining operations noted, a drift on the 400-foot level was extended north 150 feet, passing out of the old ore shoot, 400 feet long, and reaching a short distance into another one that awaits exploration.

Throughout 1901, leaching operations were actively conducted, and about 40 tons of copper cement were produced from the old dumps, and the fines from recent roasting. The dumps contain about 10,000 tons of ore roasted in past years and repeatedly leached, some of it twenty times. The sluices, carrying scrap iron, through which the water percolating through the dumps is carried, aggregate 750 feet. The precipitated cement produced carried 75 to 80 per cent of copper. During the year, the cost of production, including labor, scrap iron, and water, and excluding the original costs of mining and roasting, was less than 3 cents per pound of copper. While the price of copper was maintained, this cement brought in San Francisco 12 cents per pound for its copper contents. Sacking and transportation to New York via San Francisco cost about one cent per pound of copper contents. The total output of the mine to date is reported as 33,000 tons of ore, two thirds of which has been worked on the ground. Two 20-foot winzes and the shaft sump show that the 400-foot ore body mined maintains its width and values below the 400-foot level. These openings and the 150-foot extension of the 400-foot level constitute the only exploration in advance of mining operations.

Moon Mine.—Owned by the Moon Gold Mining Company of Valley Springs, of which J. B. Lucas is vice-president and superintendent. Situated in Secs. 3, 9, and 10, T. 5 N., R. 10 E., about two and a half miles east of Richey, and southerly from the Newton mine. There are two shafts, one of which, equipped with a horse-whim, is 100 feet deep. The other is 140 feet deep. The mineralized zone is over 1000 feet wide. Formation, diabase schist down to talcose schist; course of vein, northwest and southeast. The vein stuff is a mineralization of the schist. No large deposits of pyrite or chalcoppyrite are yet reached. Gossan croppings are from 18 inches to 8 feet in width. Grano-diorite runs to the east of all prospects in this neighborhood. The vein matter also resembles closely that of the mines in Mariposa County. Development in progress.

There are several abandoned shafts in this vicinity, on the dumps of which the same kind of vein stuff and ore can still be observed. To the west of the Moon 1000 feet is another old shaft, 140 feet deep, showing the same sort of formation as does the Moon.

Thayer Mine.—In Sec. 23, T. 5 N., R. 10 E., a little north of the Calaveras River, on a continuation of the Satellite vein. It is opened by cuts and a main shaft, which in July last was 240 feet deep. This shaft is equipped with a horse-whim. The ore is sulphide below and carbonate above.

Ione City Mine.—This property, opened in the sixties, is in Secs. 3 and 4, T. 5 N., R. 10 E. Ore sulphide and vein matter amphibolite schist, with no iron capping. Not worked since 1864. Owner, J. Boone.

Chaparral Mine.—In Sec. 10, T. 5 N., R. 10 E.; has a shaft 120 feet deep, which was opened in 1864. Now idle. The ore is sulphide and decomposed ironstone. Vein formation, schistose diabase and amphibolite schist.

Russel Mine.—This is on the Russel ranch, Sec. 10, T. 5 N., R. 10 E. The shaft is 200 feet deep. There is a large dump, 80 by 20 feet, of highly mineralized rock. The vein formation is schistose diabase. Owner, H. Russel.

Bull Run Mine.—On Wharf's ranch, in Sec. 15, T. 5 N., R. 10 E. Shaft 400 feet deep. Large dump of sulphide ore. Formation of vein, schistose diabase. Ore was shipped in the sixties from this property. It was the reported intention to work this and the Russel mine under the direction of the Buena Vista Copper Mining Company.

Copper Hill Mine.—On Copper Hill, one and a half miles north of Forest Home, in Secs. 34 and 35, T. 8 N., R. 9 E. It has been opened by several shafts, one of which is said to be about 400 feet deep. There is one over 200 feet deep, and also several shallower ones. At present, the 1000 acres of patented ground, on which are the old mines, belong to W. F. Detert, of Jackson. The first work done was in 1860-61. The mines were in operation over twenty years. Large quantities of ore and matte were shipped to Europe. Large slag dumps now on the property prove that considerable ore must have been extracted from the mine. The vein,

coursing west of north, crosses the Cosumnes River into El Dorado County at this point. The river bounds the property on the north. There are heavy gossan croppings on the vein. The vein formation, quartz porphyry, is 500 to 600 feet wide, and carries pyrite and chalcopyrite. Idle.

Mineral City Mine.—In T. 8 N., R. 9 E., owned by T. H. Allen, Jr. Shows indications of copper. The property is a half mile northwest of Forest Home, and comprises 160 acres of patented ground. Inclosing rock the same as old Copper Hill.

Forest Home Mining Co.—Property is a half mile north of Forest Home. W. H. Bradley, of Redlands, Cal., representative. There are four shafts, each about 80 feet deep. All the shafts show indications of copper ore. Idle.

Mutual Life Insurance Co.—This corporation owns 2700 acres of land one mile north of Forest Home, on which there are five shafts of unknown depths, whose dump piles all show copper ore. Idle.

W. H. Whittle.—Owns 2000 acres, one mile southeast of Forest Home, on which there is one shaft 100 feet deep, with 50-foot drifts each way from bottom, showing indications of copper ore. Idle.

An old copper mine located at Dry Creek, where the road crosses from Irish Hill to Ione, was closed many years ago. It is reported that matte was shipped from this claim thirty years ago.

CALAVERAS COUNTY.

In Calaveras County the foothill copper belt has displayed its most extensively developed mines, and from this county has come the bulk of the total copper product of the belt. Until the opening of the Shasta County mines in quite recent years this county was the preëminent copper county of the State, though its actual current production was generally small.

Calaveras County is the central one of the Mother Lode counties, and it is also centrally located relative to the entire auriferous slate belt of the Sierra Nevada slope. It is trian-

gular in shape, the apex resting on the crest of the Sierras, the base expanding along the edge of the San Joaquin Valley, and the Mokelumne and Stanislaus rivers respectively separating it from Amador County on the north and Tuolumne County on the south. One feature of its forest region is the noted Calaveras grove of "big trees" (*Sequoia gigantea*).

All physical conditions are favorable to mining. The county is richly mineralized throughout, presenting several mineral belts and districts. The Mother Lode crosses the county along a 30-mile course, and in this county displays the characteristics of vast bodies of low and medium grade ore, presenting mining propositions of the sort now especially attractive to conservative mining capital. On this lode, at the northern side of the county, is the noted Gwin quartz mine; by the southern boundary is the Melones, one of the largest mining properties in the State; and between them is the Utica group, one of the ranking gold mines of the country. Other important mines are ranged along the lode. The East Belt, farther up the slope, includes the noted Sheep Ranch mine. Other belts and districts reinforce the great and comparatively slightly developed gold resources of the county, which are now attracting marked attention. The auriferous gravel deposits of ancient river channels aggregate 50 miles in length. The gold product in 1900 was \$1,650,000, and the total mineral output \$1,905,856. Quartz crystals of rare size and quality are mined near Mokelumne Hill. Various minerals characteristic of the slope abound and await utilization. The foothill region, in which the copper deposits occur, also presents some valuable gold quartz veins. The Royal Consolidated, at Hodson, is one of the important gold mines of the State.

The copper belt, which crosses the eastern side of the county through the foothills in a northwesterly and southeasterly direction, separated from the Mother Lode belt by the Bear Mountain range, here displays two important lodes. The main one crosses the county and appears to present a fairly continuous system of veins, which display considerable variations of contents, inclosing formations, etc. At Campo Seco, on the northern boundary of the county, is a group of patented claims, quite extensively developed, and now being operated, which display strong veins and ores carrying some gold and silver. Well toward the south side of the county are the mines at

Copperopolis, the most important of the entire belt in the past, and here gold is absent from the ores. The practical continuity of this lode is shown by croppings and a great number of shallow shafts sunk all along the lode at various times. A few miles westward of this lode is another one which is traced for a number of miles and in which is the Napoleon, the pioneer developed copper mine of the State. Heavy gossan cappings characterize both lodes. In early days several mines on these lodes other than those of present interest here described were opened to considerable depths and shipped more or less ore, but they are now forgotten. Some may again be prospected at a future time.

Union Mine.—By far the most important copper mining property developed in California prior to 1896 is the extensive one known since the beginning of copper mining in California as the Union. For a great many years it has included the Keystone, which was, during the same period, the copper mine of second rank in the State. These two patented mines constitute the historical and widely known "Copperopolis Mines." They are in the town of Copperopolis, which they created in a little valley in the southwestern portion of Calaveras County, and in Sec. 34, T. 2 N., R. 12 E., on the main lode of the foothill copper belt, which here strikes 30 degrees east of south and dips about 60 degrees east. The elevation is 1000 feet.

The Union was the first copper mine of the State to be productively developed on an important scale. Large bodies of rich ore were encountered near the surface and persisted downward, and for several years succeeding January, 1861, this mine produced the bulk of the California copper ores mined and shipped. In 1866, a year or two before the Union first closed, it was credited with having shipped 56,500 tons of ore assaying 15 per cent or more, and a much greater quantity of ore of lower grade had been mined. The second largest producer at that time, the Keystone, was credited with 5719 tons shipped. The story of the Keystone during this period runs on similar lines, but this mine did not approach the success of the Union, which paid large dividends and was once held at a valuation of about \$4,000,000. Both mines were then opened to about the present depth, and operations ceased with good ore bodies displayed by the lowest workings. At 500 feet the

Union shaft was in an ore body 15 feet wide and of medium grade.

The Union remained closed from 1868 to 1887, nineteen years. In the latter year it was unwatered under the management of H. D. Ranlett. The main shaft was sunk to 600 feet, and mining was resumed for about a year and a half, during which time 5000 or 6000 tons of ore were shipped. In 1889 a 100-ton Orford smelting furnace was installed, without very successful results. Operations again ceased in 1892. Leaching the dumps has been carried on during many years and a large amount of cement copper has been produced. The mine was again unwatered last year.

The formation in which these mines occur is black pyritous slate and amphibolite schists, and can be traced through Calaveras County north into Amador County and south into Tuolumne County. The lode in which are the Napoleon and Campo Seco mines is to the westward, the distance being about six miles from Copperopolis, while the Campo Seco mines at the northern boundary of the county are about three miles west of the Copperopolis lode, as the latter is termed in this county. At the Union mine, and for a considerable distance north and south, this lode presents a single vein of black pyritous slate in a belt of amphibolite schist, this formation exhibiting no material variations. The United States Geological Survey has shown both vein and inclosing formation to be identical in age and character with the slaty veins and amphibolite schists (greenstones) of the parallel Mother Lode about twelve miles to the east. At Copperopolis the vein is from 3 to 40 feet wide, and occupies the trough of a small valley which here averages a half mile in width, the valley itself being the result of the erosion of the soft slate and of the softer greenstones directly bounding it. Being covered by detritus and vegetation the vein exhibits no croppings in the immediate vicinity of Copperopolis, and copper stains were the only indications which guided the prospecting that led to the discovery of the rich ore bodies below.

The Union and Keystone patented claims comprise 5254 feet of the lode. The property of the Union Copper Mining Company, which is controlled by the estate of Frederick L. Ames of Boston, also includes the Empire, the undeveloped south extension of the Union, and 800 acres of patented agricultural

land north and south of the mines, giving the company possession of over three miles of the lode. Production has been confined to the Union claim and the south end of the Keystone claim, and underground exploration practically so. The vein, which in these claims exhibits a maximum width of about 40 feet and an average width of about 15 feet, carries a succession of ore bodies which are lenticular masses of sulphide copper ore (chalcopyrite) connected by stringers of ore. The water level is here very close to the surface, and the alteration of the sul-



UNION COPPER MINE, COPPEROPOLIS, CALAVERAS COUNTY.

phides has extended to a depth of about 30 feet only. Within this zone of oxidation the ore bodies below the surface gossan present a little native copper, and carbonates and oxides that are frequently very rich. There is no zone of secondary enrichment, and below the depth of 30 feet the unaltered sulphides extend downward practically unchanged in character and average copper content to the greatest depths yet reached.

But three ore bodies have yet been opened and worked. Two of these outcrop in the Union and one near the south end of the Keystone. These ore shoots dip eastward with the vein

and also longitudinally to the north. The largest one is the southernmost one, in the Union claim, and is about 300 feet long, from 2 to 40 feet wide, and has been followed to a depth of 600 feet, where it reaches the northern vertical boundary of the Union claim. One stope in this body, from which ore was extracted in the decade of the sixties, was about 40 feet wide, 80 feet high, and 100 feet long. The next shoot to the north in the Union claim is 200 feet long, is of less average width, and reaches well into the Keystone property, where it has been worked to the same depth as the larger ore body. The developed Keystone ore body is 100 feet long, from 1 to 15 feet wide, and is exactly similar to the others in character. It has been worked to a depth of 250 feet. The underground openings of the Union and Keystone claims, consisting of several thousand feet of drifts, shafts, and stopes, are connected. Nine levels have been run in the mine and six shafts have been sunk to varying depths on both properties, but one of which is now equipped for hoisting and pumping.

Accurate maps and records of the workings and product have been kept, and since the recent unwatering of the mine and the resumption of prospecting therein, the mine has been carefully experted and existing ore reserves blocked out. It is stated that the estimates arrived at are that the three ore bodies described, when worked by modern methods, will yield several hundred thousand tons of pay ore above the depth of 900 feet. This estimate assumes that the ore shoots will display the same persistence of average size, character, and value to that depth that they have shown from the surface to the lowest levels. The question of the permanence of values at depth in this foothill mineral belt is, in a way, quite as interesting and important as the same question in regard to the parallel Mother Lode. Within recent years this question has been affirmatively decided along the Mother Lode, especially in the neighboring county of Amador, and at the Gwin mine, in Calaveras County, where extensive and valuable ore bodies are being mined at a present depth of about 2000 feet. This problem gives significance to the persistent characteristics of the ore shoots at Copperopolis and to the geological identity of the veins and inclosing formations of both lodes.

Within the limits of the Union and Keystone claims, and outside of them along the lode through this company's prop-

erty, superficial prospecting has revealed the buried outcrops of a number of other ore bodies, all of which are remarkable in their similarity to the three developed ore bodies at the surface. The prospecting and developing of such new ore bodies await the future.

The Union ore bodies are, as indicated, practically solid masses of sulphides, carry no gold or silver, and are exceptionally free from baser metallic elements. These ores thus differ from those of the Napoleon-Campo Seco lode to the west, which carry gold, silver, and baser elements. It is stated that the copper product of this mine has generally been used for the manufacture of copper wire without electrolytic refining.

Since the mine was unwatered last year prospecting at depth has been actively carried on, mainly on the 600-foot level. The product has been two grades of ore—one a smelting ore averaging 11 per cent of copper, and the other a leaching ore averaging 5 to 5½ per cent. The mining operations have yielded about two tons of the latter to one of the former, but the low-grade leaching ore has been largely taken from the radiating stringers. Since the re-opening of the mine the operations have been conducted by General Manager G. McM. Ross, and a definite working plan of future operations is now being considered. On the dump are now 30,000 tons of 3 per cent ore which it is intended to concentrate, and 40,000 tons of partially leached ore averaging 2½ per cent in copper.

The surface plants, erected years ago, are extensive and include a large leaching plant, necessary buildings, hoist, pumping plant, etc. The mine yields a maximum of 80,000 gallons of water per twenty-four hours. Steam power is used, wood costing from \$3.50 to \$4 per cord. Water is pumped from a creek half a mile distant. Timbers and lumber are supplied from Stockton and the mountains to the east. Underground labor costs from \$2.25 to \$3 per day, and surface labor \$2. The Union Electric Light and Power Company, which is under the same control as the mine, owns 1200 acres of land, largely gold placer ground, on the Stanislaus River at the southern boundary of the county, and there are several miles of water ditch. This property was secured to provide a supply of water and power for the mine and town.

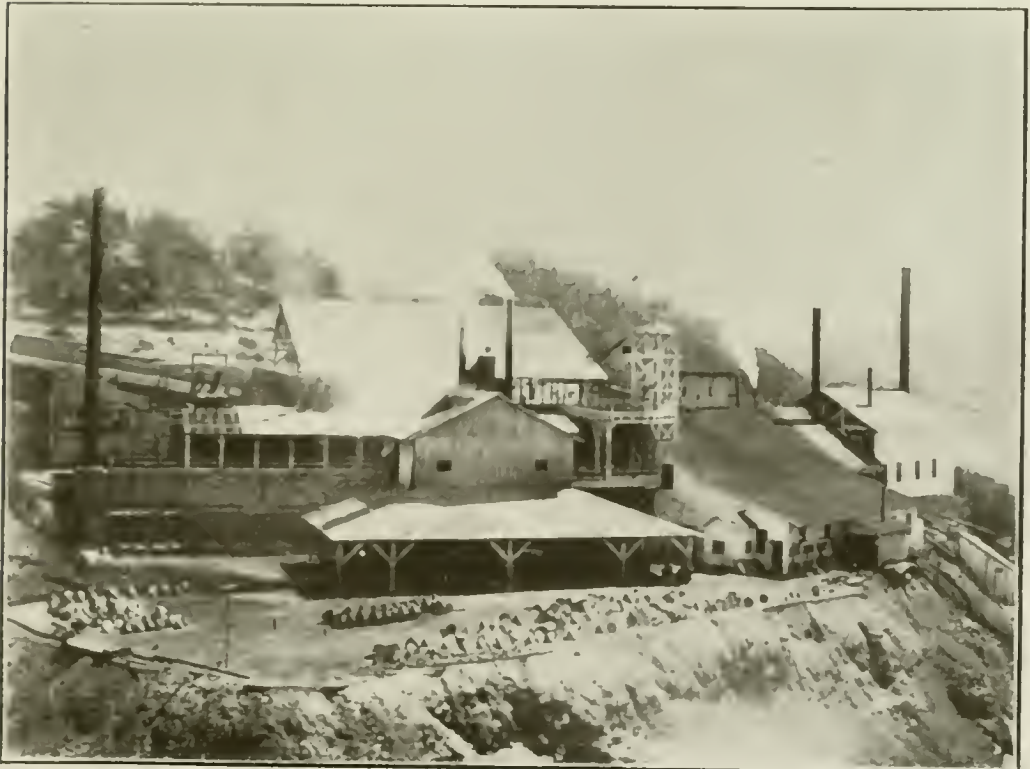
It may be assumed that the Union property will again become a producer sooner or later. Copperopolis, which was

a thriving and important town during the early mining activity there, is fourteen miles from Milton, the terminus of a branch railroad, and about forty miles from tide water at Stockton.

Penn Chemical Works.—Second in importance only to the Copperopolis mines among the copper-producing properties of the foothill belt in the past has been the group at Campo Seco, essentially composed of the Heckla, Campo Seco, and Satellite mines, which were operated as separate mines in former years and which now, with the Little Satellite, comprise one property under the name given above. The first three mentioned were producing mines in the early sixties and were important ones in those days. They are close to the town of Campo Seco, by Mokelumne River, about twenty miles northwest of Copperopolis, and on the western lode of Calaveras County. Valley Springs, the terminus of a narrow-gauge railroad, is four and a half miles distant. In early days many thousand tons of ore were mined. The richest was shipped in considerable quantity and large amounts of medium and low grade ores on three dumps have been leached intermittently to the present day. Some matte was produced from small furnaces before the plant now operating was installed. The veins here course and dip as at Copperopolis. The vein matter varies in character, the gangue being variously composed of talcose schist, clay, quartz, etc. The ores are sulphides, associated with iron pyrites, and carrying small percentages of gold and silver, with occasional traces of zinc. This group of claims has been opened by five shafts and some tunnels, two of the shafts now being operative. The deepest development has occurred in the Heckla and Satellite, which at an early period were opened to depths of about 500 feet. The Campo Seco shaft reached 250 feet and its lowest level was at 200 feet. One ore body in the Heckla mine was 150 feet long, and the group as a whole has yielded quite largely. The Satellite has undergone the most extensive development. The shaft is 550 feet deep and four levels have been opened, from which ore is now being mined. This mine was well known as the Lancha Plana before 1883, when it was re-opened by H. D. Ranlett after long idleness. A tunnel was run to the old shaft, about 1000 tons of ore shipped, and leaching continued for about three years. It was then sold to the San Francisco Copper Company, and later merged with the



PENN COPPER MINING COMPANY'S MINE AT CAMPO SECO.



SMELTING WORKS OF THE PENN MINING COMPANY, AT CAMPO SECO.
(195)

Penn Chemical Works property. Mining and prospecting are actively proceeding. The present smelting plant includes one 100-ton water-jacket furnace. The pyritic method of smelting is pursued. The material is run through the furnace three times, producing matte respectively of 20, 40, and 60 per cent. Recently about 150 tons of 60 per cent matte have been shipped monthly. Another feature of the plant is a small furnace used to agglomerate and partially desulphurize the fines. There are now 85 men employed. Besides the smelting



NAPOLÉON COPPER MINE, CALAVERAS COUNTY.

operations, the old low-grade ore-dumps are being leached and cement copper is being produced. A. C. Harmon, Campo Seco, is general manager.

Adjoining the Satellite and parallel with it is the Meteor, and the Constitution is an extension of both the former claims. C. Borger, Campo Seco, owns both claims.

Napoleon Mine.—This, the oldest copper mine in the State, lies to the south and west of Copperopolis about nine miles, and is in Sec. 23, T. 1 N., R. 11 E. It is thirteen and a half miles

from Milton. The owner is Josephine H. Sullivan, who has bonded the property to Messrs. Lewis and Ben Williams. They are now sinking shafts, running drifts, and otherwise prospecting the ground. The vein channel is 100 feet wide, and consists of diabase and meta-diabase down to talcose schist. The ore bodies occur in lens-shaped masses from stringers to 20 feet in width. The shaft is 86 feet in vertical depth and then inclines 62 degrees for 239 feet, giving a total depth of 325 feet. The ores are principally sulphides, although carbonates and oxides are plentiful. The mine, which was first opened in the sixties, was filled with water from 1866 to 1900, when the Williams Brothers commenced operations. A new west shaft is now being sunk to connect with old workings on the 250-foot level. It is now down 185 feet. Cement copper is produced from leaching the old dumps, and some satisfactory shipments of ore have been made.

Star and Excelsior.—In Sec. 24, T. 1 N., R. 11 E., near the Napoleon; opened by cuts, shafts, and tunnels, showing an ore channel from 75 to 100 feet in width. The ores are sulphide and carbonates. The mines are now idle. The owners are Messrs. Weihe et al., of San Francisco.

Collier Mine.—In Sec. 24, T. 1 N., R. 11 E., near the Napoleon; owner, Henrietta Botcher, of Stockton. There is an old caved shaft on the property. The vein is reported to have been rich in copper, which was shipped in the sixties. Idle.

Eagle Mine.—In Sec. 3, T. 1 N., R. 11 E., on Quail Hill; owner, J. M. McDonald, of San Francisco. Contains sulphide and carbonate copper ores. Idle.

Near Milton are some prospects showing copper, but they are not developed enough to demand specific mention.

Josephine Mine.—In Sec. 8, T. 1 N., R. 13 E.; known also as the Old Mountain Top mine. It has a shaft 40 feet deep, sunk in 1864. The vein is 4 to 5 feet wide. A little ore remains on the dump and in the shaft. Shipments were made from this claim in 1864.

Through the Pattee ranch, adjoining the town of Valley Springs on the east, extends a belt of copper-bearing rock 1000 feet wide, with a strike west of north. The ranch contains 784 acres. On this belt there are shafts and open cuts. The deepest shaft is 80 feet, and shows copper ore. The vein matter here is amphibolite schist and schistose diabase. There has been no development since 1864.

The De Martini ranch, the second ranch below the Pattee ranch, has recently been bonded to a company which intends to re-open the old shaft and explore the property. Two creeks cut through the belt on this ranch and reveal copper ore.

On the Missenger ranch, about two and a half miles north of Valley Springs, is a shaft about 400 feet deep in the old '49 mine. There is also a large dump of oxidized and sulphide ore. About two and a half miles farther north, near the Mokelumne River, is another shaft called the "Salt Gulch."

Jackson McCarty Mine.—Known also as the old Calaveras mine; about three miles north of Copperopolis, in Sec. 23, T. 1 N., R. 12 E. It has a shaft 250 feet deep. Idle.

Caledonian Mine.—On the road from Valley Springs to Gaslen's ranch; has a shaft 250 feet deep, sunk in the sixties. Idle.

A. S. Pool has been opening a prospect in Sec. 10, T. 2 N., R. 12 E. The vein is 20 feet wide, inclosed between a foot wall of slate and a hanging wall of diorite. The vein matter is meta-diabase. The copper value as reported ranges from 2 to 20 per cent, and the gold from \$4 to \$7 per ton. The vein is opened by one shaft 35 feet deep and a deep cross-cut.

East of the Mother Lode there are found occasionally quartz veins carrying copper in considerable quantities, notably on San Domingo Creek, near Macaroni Flat, where there is an old shaft and a large dump, which show considerable copper ore and some native copper.

ALPINE COUNTY.

Walter W. Bradley.

Some of the occasional occurrences of copper along the higher portion of the Sierra Nevada range are to be noted in Alpine, a small elevated county which straddles the crest of the range and lies east of El Dorado, Amador, and Calaveras counties, and west of Mono County and the State of Nevada. It is remote from railroads, and its small population devotes its energies mainly to mining, stock-raising, and lumbering. Gold- and silver-bearing lodes are abundant, but the ores are largely base and the mining industry is in a backward state. Quite a number of important mines have been developed and operated, however. This remote region has frequently, but erroneously, been given the honor of possessing the first copper deposit discovered and opened in the State. This deposit was found in Hope Valley in 1855 by "Uncle Billy" Rogers. The ore occurred in the form of a "chimney," presented a beautiful appearance, was rich in garnets, and attracted considerable attention for a brief time. Other deposits of better commercial value were later discovered and opened. Two have been noted.

Leviathan Mine.—Owned by D. Bari, of Silver Creek, California. The mine is located ten miles east of Markleeville. The nearest point to a railroad is Carson City, forty miles distant. There is a 400-foot tunnel tapping the ledge 250 feet below the outcrop; 200 feet below this tunnel another tunnel is in 700 feet. Both tunnels are connected by a winze. The ore occurs in kidneys in porphyry. About 300 tons of ore have been shipped to a smelter. The property is idle at present.

Stella Mine.—Located two and a half miles southwest of the Leviathan, and is owned by an English company. The mine has been operated for silver and copper. There is a 300-foot shaft and hoisting apparatus. Water power is available. The mine is idle at present.

The Morning Star mine, an old mine in the Mogul district north of Markleeville, has recently been again productive. It is operated as a gold and silver property, but the ore carries a good deal of copper. One lot of 22 tons mined last year is reported to have yielded 17 per cent of copper, and \$32 in gold and 49 ounces of silver per ton.

TUOLUMNE COUNTY.

Another of the great gold-mining counties of the slope crossed by the foothill copper belt is Tuolumne, a large, irregularly shaped county, which stretches its eastern and longest boundary far along the Sierra crest, reaches westward down the slope between torrential streams, and claims a small section of the foothill region with its narrow western end. It is a part of the Wonderland of the general region of the Yosemite Valley, which lies to the south, and includes about half of the Yosemite National Park and of the Stanislaus forest reserve. Hetch-Hetchy Valley and some of the higher peaks of the range are among the varied features of its scenic grandeur. It has a wealth of natural resources yet but slightly exploited. Agriculture and horticulture flourish more largely than in some neighboring counties, and there is an extensive lumber industry. Splendid opportunities for the extensive generation of electric power are presented.

Mining is yet by far the dominant industry of the county. Its rich early placers have been succeeded by an era of quartz mining, which for some time has been showing marked progress. Few counties of the State have recently attracted so much mining capital to their gold mining fields or seen more active development of successful or promising quartz mines. The Mother Lode crosses its western part and affords some of the best and well-known mines of the State. The East Belt, paralleling the Mother Lode, shows its most valuable and most extensively developed mines in Tuolumne County. The base-ore belt of the high Sierras is wholly undeveloped here, as in other counties.

The county's mineral resources are widespread and various, but gold, and a little silver mined with it, yet constitutes practically the only mineral product. The output in 1900 was \$1,596,891 in gold and \$62,367 in silver. Besides the great continuous belts along which gold mining is mainly concentrated, there are districts containing many rich pocket mines. One of these mines has yielded \$2,000,000. The Sierra Railway crosses the foothill and Mother Lode belts and terminates in the lumbering and mining region of Carters, affording direct

communication with the most populous and productive portions of the county.

Through the western end of the county the copper belt presents two branches. It enters the county from the north closer to the Mother Lode belt than elsewhere, being but two or three miles westward. The two divisions of the belt diverge somewhat in crossing the county southeasterly, and both are marked at intervals by outcrops of cupriferous veins and by old shafts of shallow depth, which mark the many prospecting efforts of former periods. A few properties have shipped a little ore, mainly forty years ago, but no mines of note have yet been developed. Many of the deposits carry gold, and in a few gold affords the chief incentive to exploration. The western branch of the belt is the stronger one. From Copperopolis, in Calaveras County, it enters Tuolumne County at Byrne's Ferry, and passes through the Don Pedro district to the southeast. The eastern branch enters the county just west of Tuttletown and passes out at Moccasin Creek at the south. The copper belt is clearly defined, exhibits favorable indications, and, as do other sections of the belt, presents strong possibilities for the future.

On the Kohl ranch, in Secs. 6 and 7, T. 1 N., R. 14 E., west of the Rawhide gold mine, and to the west of the Serpentine, the east branch of the copper belt is traced by croppings and cuts. The vein matter here has the appearance of a chloritic schist.

On the Shell ranch, in Sec. 17, T. 1 N., R. 14 E., southwest of the Rawhide mine, on the flank of Table Mountain, a copper deposit exists. This ore is rich in gold.

In the town of Chinese Camp is an old shaft about 100 feet deep. The dump shows good copper ore. This is in Sec. 9, T. 1 S., R. 14 E.

On the Olson ranch, in Secs. 31 and 32, T. 2 S., R. 14 E., is the old Golden City mine, which shows copper ore. The mine, however, has been worked chiefly for its gold.

On the Mackay ranch, in Sec. 28, T. 1 N., R. 14 E., is a shaft in croppings showing copper ore, mainly carbonate. Not much development work has been done.

On Moccasin Creek, in Secs. 19, 20, 28, and 29, T. 1 S., R. 15 E., are copper croppings and a shaft 22 feet deep, show-

ing chalcopyrite. From the Tuolumne River going south in this range a deposit of copper with heavy ironstone cap can be traced by croppings for over a mile.

Along the west lode the following properties are noted:

Washington Mine.—In Secs. 30, 31, and 32, T. 2 S., R. 15 E. The owners are W. E. Hensley and G. A. Hensley. There formerly was a town of over 400 people sustained by the mine. The town was destroyed by fire, the price of copper depreciated, the place was deserted, and has ever since remained so. The ores are of a very good grade, sulphides predominating. The vein formation is diabase and meta-diabase. A cross-cut is now in 16 feet of ore.

On Donahue's ranch, in Sec. 23, T. 2 S., R. 14 E., there is an old tunnel said to be 1000 feet long, with good copper ore on the dump. The former superintendent, Mr. Z. Brown, shipped some high-grade copper ore.

In the Don Pedro district the copper belt is clearly traced in its course northwesterly. Prospect holes are found in Sec. 9, T. 3 S., R. 15 E.

On the Blanchard place is a shaft 60 feet deep, in which is exposed good chalcopyrites. At Montezuma is the Ohio House mine, showing good copper ore. On the W. N. Adams place, in Sec. 16, T. 3 S., R. 15 E., are shafts and open cuts, showing copper ores, which were opened in the sixties.

Oak Hill Copper Mine.—Located west of the course of the west belt, near the river and Cooperstown, in Sec. 23, T. 2 S., R. 15 E. Owners, Henry Willey, A. H. Fitch, et al.; postoffice address, Cooperstown. The vein is of unknown width. Development, one shaft 112 feet deep, with drift 73 feet south. There is also an old shaft on the claim. There is a good wagon road to Cooperstown, a station on the Sierra Railway. When visited, three men were employed and ore was being shipped.

East of the Mother Lode, in Secs. 20 and 21, T. 2 N., R. 17 E., copper ore in quartz occurs in considerable quantities. This deposit is similar to one described as the Robert mine in El Dorado County. Little development work has been performed. The ore is regarded mostly for its gold value.

MARIPOSA COUNTY.

In Mariposa County the copper belt presents some of the extensive ore bodies developed along the belt outside of the few larger producing mines to the north, and the deposits here are most noteworthy, on account of the large percentage of gold frequently carried by the ores. Some of these ore bodies attracted attention during the earliest years of the industry, and here were some of the earliest mining operations and attempts at copper smelting. Thousands of tons of ore have been mined and shipped, with or without concentration, and in the sixties the industry supported a considerable population. During the recent copper activity several promising properties, old and new, have been opened and actively developed. The extent of some of these deposits and the amount of their precious metal values make it almost certain that they will become important mines sooner or later.

Mariposa County covers a large area of the Sierra slope at about the latitude of San Francisco, has an irregularly triangular shape, and, unlike Tuolumne County on its north, has the base of the triangle it constitutes in the foothills and its narrow end near the crest of the range. It shares the rugged topography, forests, and abundant waters characteristic of the slope. The county is chiefly known to the world through its possession of those natural wonders, the Yosemite Valley and the chief groves of the kingly *Sequoia gigantea*, or "Big Trees." A branch railroad reaches to Raymond in Madera County close to the southwestern boundary, but the county is handicapped by lack of convenient transportation facilities.

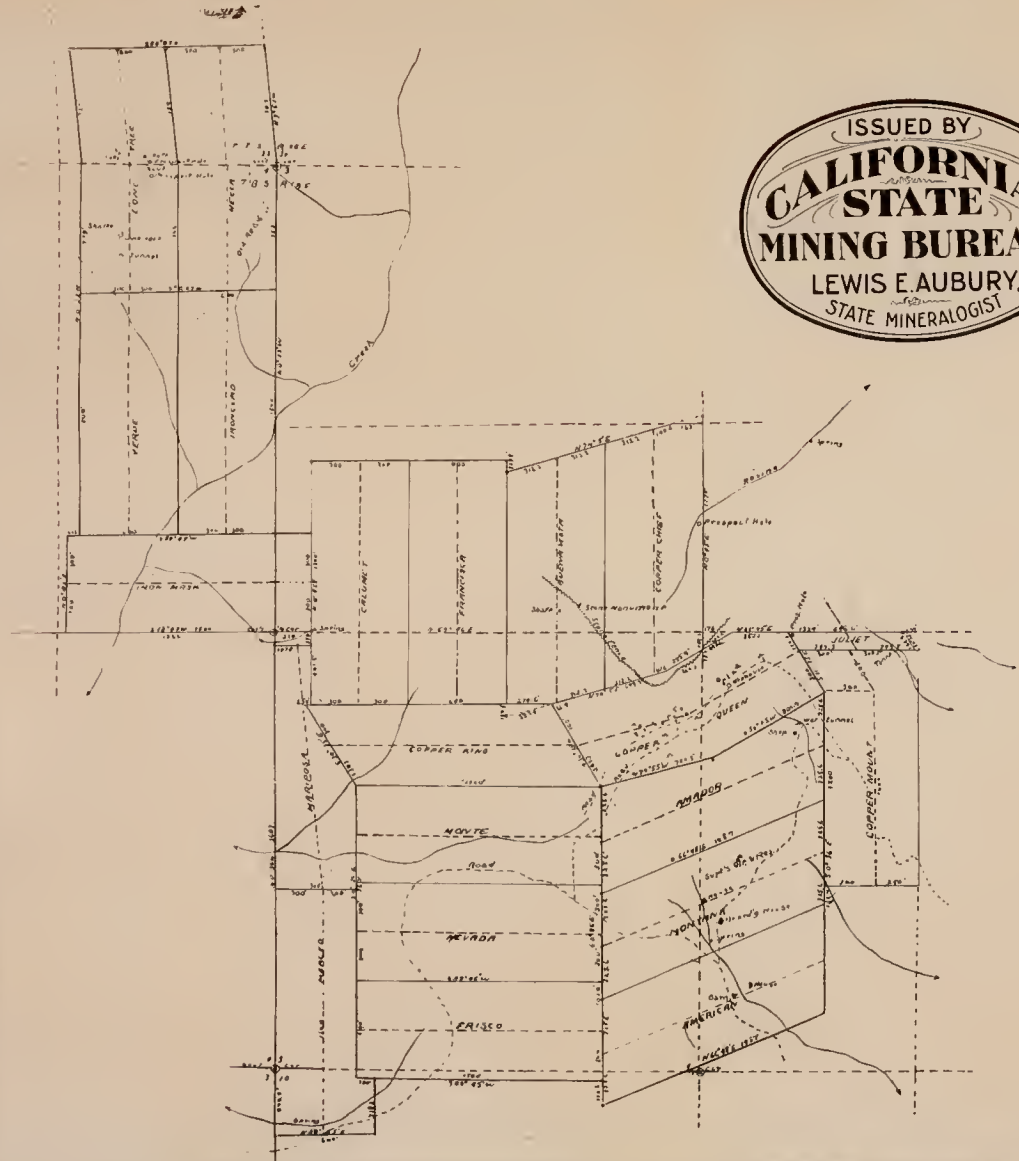
While the county has various resources and attractions, it is and will remain chiefly a mineral county. As such it has an important future. It is full of opportunities for legitimate mining enterprise backed with sufficient capital. The great Mother Lode courses through the county and finds its southern terminus in the southern part of this county, where it loses its identity and is succeeded by the irregular system of quartz veins which continues far southward along the slope. In Mariposa County the Mother Lode is characterized by the

great width of its quartz veins and ore bodies. About fifteen miles of the lode are included in the Mariposa Grant, an estate of over 44,000 acres, owned by a company that is now re-opening some old mines, one of which yielded \$4,000,000 many years ago. Another section of the lode is included in the 20,000 acres held by the Merced Gold Mining Company. Some miles from the Mother Lode is the East Belt, one of whose mines has produced \$2,500,000. The copper belt running through the foothills courses for forty miles through Mariposa County, and here there has been a great deal of recent activity in the opening of both gold and copper mines. Communication with this region is by highway to railroad points along the east side of the valley below. The copper properties here described are mainly taken in succession northward from the south side of the county.

Near the south line of Mariposa County, in R. 18 E., is Green Mountain, a considerable prominence through whose summit passes a vein of ironstone carrying copper. This vein is a part of the great California copper belt, and at this locality has a large, heavy, bold cropping of gossan, which is a hydrated, silicious iron oxide, the decomposed remains of a solid iron sulphide rock that contained copper. All the copper, formerly doubtless in the condition of copper sulphide, has not leached out of this gossan mass. A small amount, from 1 to 4 per cent, sometimes remains on the decomposed surface material, and in several instances has been the means of leading to the discovery of the masses of richer copper ore lying below the zone of decomposition.

Green Mountain Mines.—Situated about six miles west from Raymond, in Secs. 31 and 32, T. 7 S., R. 18 E. The owners are O. R. Sydney et al.; postoffice address, Le Grande. The mines have been worked at various times since 1863, and have produced large quantities of high-grade copper oxide and carbonate ores. Thousands of feet of tunnels and drifts have been run in development and for the extraction of ore. These openings, as well as the croppings of gossan, show the vein, or deposit, to be from 300 to 1200 feet in width between the inclosing walls of grano-diorite on the east and diorite on the west. There is a large number of openings on the property, the most important of which are two tunnels several hundred





GREEN MOUNTAIN GROUP OF MINING CLAIMS, MARIPOSA COUNTY.



GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.



DUMP OF THE GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.
(205)





GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.



DUMP OF THE GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.
(205)

feet in length, above which are the stopes and chambers from which the best ore has been taken and shipped. The lower or east tunnel is in 600 feet. At about 400 feet it has cross-cut a vein 60 feet in width. This is said to carry good values in copper and gold. The main body of ore lies back of this, the openings or workings of which are about 60 feet above the tunnel level, to which they are all connected by an upraise. From this upraise, several hundred feet of drifts and chambers are run in sulphide ores of good value. Thus far, no walls have been found in these workings. About 900 feet west from the above tunnel, and 50 feet above it, another tunnel has been run several hundred feet, and from it a large quantity of carbonate and sulphide ores has been extracted and shipped. The conditions in this last tunnel are about the same as they are in the one first specified, *i. e.*, a large area of sulphide ore has been exposed, but no walls found. The owners are now making arrangements to explore these vast bodies of ore with diamond drills.

Lone Tree Mine.—This property, situated a short distance west from the Green Mountain, with the same ownership, shows a well-defined vein of schistose rocks, or coppery gangue, about 300 feet wide, from which large quantities of carbonate ores have been extracted and shipped. This mine is opened by several shafts, varying from 25 to 100 feet in depth, all showing copper ore of good quality. No sulphides have yet been reached on this property. The average depth below croppings, in both the Green Mountain and Lone Tree mines, to which the gossan extends, is about 100 feet. Development.

Cavan Mining and Milling Co.—This company's property lies in Secs. 4 and 5, T. 8 S., R. 18 E., nine and a half miles from Raymond, Madera County, and comprises 235 acres of ground with millsite. The headquarters of the company are at Stockton. The resident superintendent and vice-president is I. C. Leonard. The development work on the property has been to the extent and on the claims specified below. The mines are all in the copper belt, are easily accessible from the railway, and are favorably located for economical work.

On the Rothchilds claim is a cross-cut tunnel, which is expected to reach the vein in this claim at a depth of 250 feet, and in the Good View at a depth of 375 to 400 feet. The



AT THE GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.



LONE TREE MINE, MARIPOSA COUNTY.

tunnel was in 240 feet when inspected. There is a 20-foot shaft on the south end of the Good View. This follows a streak of ore 6 to 8 inches in width, from the top of the shaft to near the bottom. There is an ore vein on the surface 20 inches wide. The ore from these streaks is said to average 15 to 25 per cent copper. The streak shows at intervals for over 1400 feet in length. The whole width of the two claims, viz., 1200 feet, exposes layers of quartz, slate, ironstone, schist, shale, and sandstone. The main shaft was down 140 feet. The vein exposed varies from 6 inches to 6 feet in width, showing, down to 75 feet, oxidized copper ores, azurite, malachite, etc., but below 75 feet the ore is solid pyrites and chalcopyrites. Smelter returns of shipments of this ore show 31 per cent copper. There are two other shafts, down 40 and 54 feet each, showing ore of the same character as in the deep shaft, 10 to 24 inches in width from top to bottom. The vein matter is mainly diabase or meta-diabase, is 400 to 500 feet in width, and is known to be over 10,000 feet in length.

The Sunset claim has a shaft down 58 feet, showing reported values of 17 per cent ore from 10 feet below the surface to the bottom of the shaft. The ore varies from 6 to 30 inches in width. There is a schistose (diabase) foot wall and for 1000 feet a serpentine hanging wall. This serpentine at its ends changes into a brownish schistose rock. The vein matter consists of stringers of quartz, schistose, and ironstone rocks, all more or less mineralized. The ore bodies are lenticular.

On the Crown Point and Little Giant surface work only has been performed.

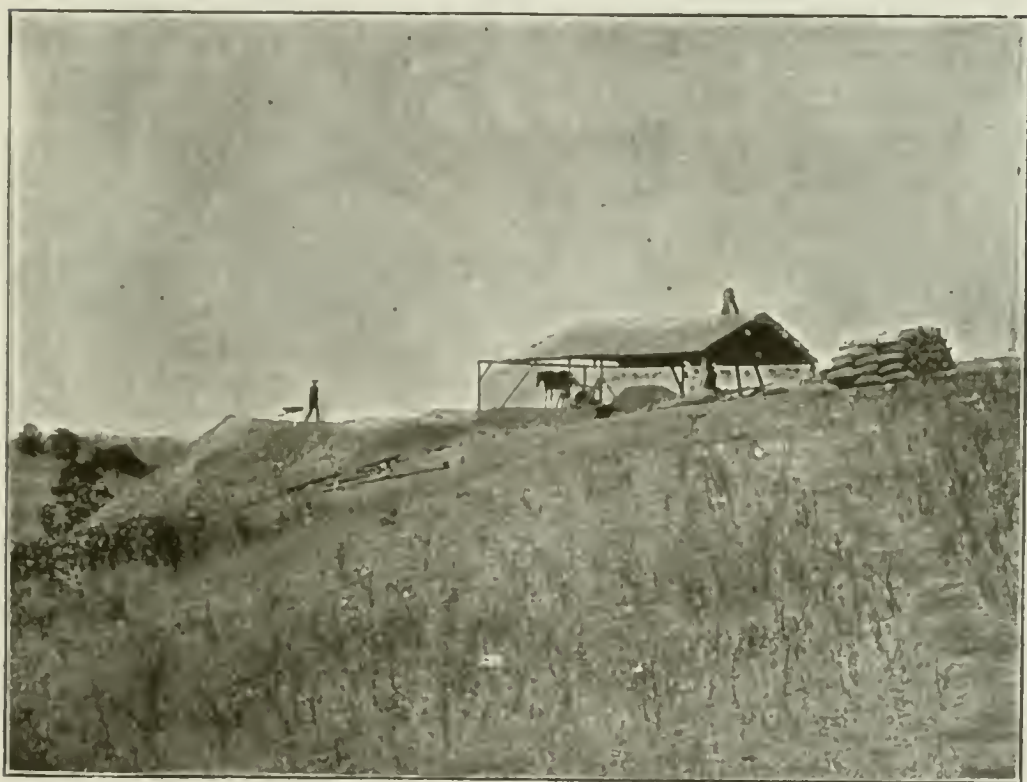
On the Copper King there are two shafts, one 20 feet and one 50 feet deep, both showing ore from top to bottom, 6 to 30 inches in width. No drifting has been done from these shafts. There is also a cross-cut tunnel 65 feet long.

The San José has a cross-cut tunnel 170 feet long. Three winzes from this tunnel, respectively 40, 80, and 115 feet deep, show an ore shoot 65 feet long and 4 feet wide. The 115-foot winze shows good ore from top to bottom. The ore at the bottom is $4\frac{1}{2}$ feet wide. The hanging and foot walls appear to be about 700 feet apart; for that distance the same vein formation of meta-diabase (schistose rock and talcose schist), ironstone, and quartz appear, as in other places.

The Stonewall Jackson shows on the surface croppings of

quartz carrying copper ore (chrysocolla) 5 feet in width, and a solid body of decomposed silicious iron from 75 to 100 feet in width. Development in progress.

Great Northern Mine.—In Secs. 2, 3, 10, and 11, T. 7 S., R. 17 E. Owners, S. A. and C. R. Wilcox. There are three shafts, 25, 70, and 110 feet in depth. Cross-cuts are run from the bottom of the deepest shaft for about 40 feet. The ore body is from 1 to 8 feet in width. The vein matter is of a



POCAHONTAS COPPER MINE, MARIPOSA COUNTY.

schistose (meta-diorite) character. The ores are green carbonates, yellow and black-blue sulphides. Wood and water are not plentiful in the immediate neighborhood. A shipment of ore was reported to have yielded 15 per cent copper and no gold. Idle.

Pocahontas Mine.—In Sec. 14, T. 7 S., R. 17 E.; owned by Mrs. Abbey Waller. When visited it was under bond and being worked by William McIntosh and W. M. Darling of San Francisco. The property consists of 160 acres of patented land, through which runs a belt of several seams, or veins, of

iron ore carrying copper. The general strike of these veins is in a northeasterly direction. This belt of veins has a grano-diorite east wall and a diorite west wall, and dips to the east. The vein matter is mainly diabase and altered diabase, a hard, shiny, bluish-gray rock that is frequently highly mineralized, and with its inclosures of pyrites and chalcopyrites constitutes the ore masses of these copper mines in Mariposa County. The width of the principal vein is practically 100 feet between its inclosing walls. Between the grano-diorite and diorite the distance in places is over 1000 feet. The deposits of metallic sulphides, viz., iron, copper, and zinc sulphides, occur in lenses. One of these bodies being worked on the Pocahontas is known to be 50 feet long, 4 feet wide, and over 100 feet deep. It consists of a dark-colored sulphide ore, said to carry from 6 to 12 per cent of copper and \$2.50 in gold. Carbonates of copper predominate down to the 100-foot level, where it all changes into sulphides. The vein is traced through the whole length of the property and extends both ways into other properties. There are several openings on the main vein, some of which were made in the sixties. The main shaft, through which all the development is now being done and ore extracted, was over 100 feet deep, with a promising body, in size, of the best quality ore discovered in the mine. This is a dark-blue sulphide ore. Green carbonate ore has been shipped that yielded 35 per cent copper. Other carload shipments have given 30 per cent copper. There is on the dump over 350 tons of ore of good grade. The former lessees (Wilcox Bros.) within the three years shipped over \$30,000 worth of copper ore. The adjacent country consists of low rolling hills and grazing land, is easy of access, and is twenty-four miles from Merced, and about fifteen miles from the Santa Fé Railroad.

White Rock Copper King Mine.—In Sec. 14, T. 7 S., R. 17 E. It lies about a quarter of a mile west of the contact of the grano-diorite belt. The vein matter is schistose diabase, 25 feet and upward in width. There are heavy gossan croppings. Cuts, shafts, and openings in these croppings show that these decomposed masses extend downward for more than 30 feet. The main shaft is over 150 feet deep. This is equipped with a whim hoist. Development work in this shaft



WHITE ROCK, MARIPOSA COUNTY.



WHITE ROCK MINE, MARIPOSA COUNTY.

was in progress. Below 100 feet the ore is sulphide. From the shaft there are over 175 feet of drifts, all in ore. The vein channel is 100 feet wide, as shown by these drifts. Several carloads of oxide and carbonate ores were shipped, which yielded 35 per cent copper. During December there were shipped 50 tons of black oxide averaging 32 per cent. On the dump there are several varieties of copper ore, while the bottom of the shaft is in good sulphide ore. One carload of ore was shipped that assayed over 40 per cent copper. The vein is traced southward to the Green Mountain mine, a distance of over three and a half miles, and northward for over half a mile. The ore carries from \$1.50 to \$2.50 in gold and 1 to 3½ ounces of silver per ton. About 100 feet to the east of the main shaft is a hole 10 feet wide, 15 feet long, and 40 feet deep, all in gossan. This gossan contains from about 4 to 7 per cent of copper. The superintendent of the property is Edwin L. Foster; postoffice address, Lewis. The mine was discovered in 1900. At this point the copper belt is known to be over three and a half miles wide. The property is about thirteen miles east of Le Grande, on the Santa Fé Railroad, and easily accessible.

Throughout the belt of country in which are the Green Mountain, Pocahontas, and White Rock mines, can be seen on almost every knoll, for a width of three or four miles, very heavy croppings of decomposed ironstone which carry copper. All of these have a general northerly and southerly trend. This character of formation, with slight modifications, extends up to and beyond Hornitos, but is particularly noticeable in the White Rock section. Another feature of the White Rock section is the frequency of strong white quartz croppings, from the principal one of which the district derives its name.

Cornett Copper Mine.—In Sec. 19, T. 6 S., R. 17 E.; H. W. Cornett, owner. The sulphide ore appears at the surface. The vein matter is schistose diabase, the most mineralized portion of which forms a vein 34 inches wide. The grano-diorite belt is only a short distance to the east. The ore is mainly sulphide, and 160 sacks of it, shipped, yielded 17, 22, and 23 per cent of copper, \$2.26 and \$4.60 in gold. The deposit is about twenty-one miles east of Merced. Developing.

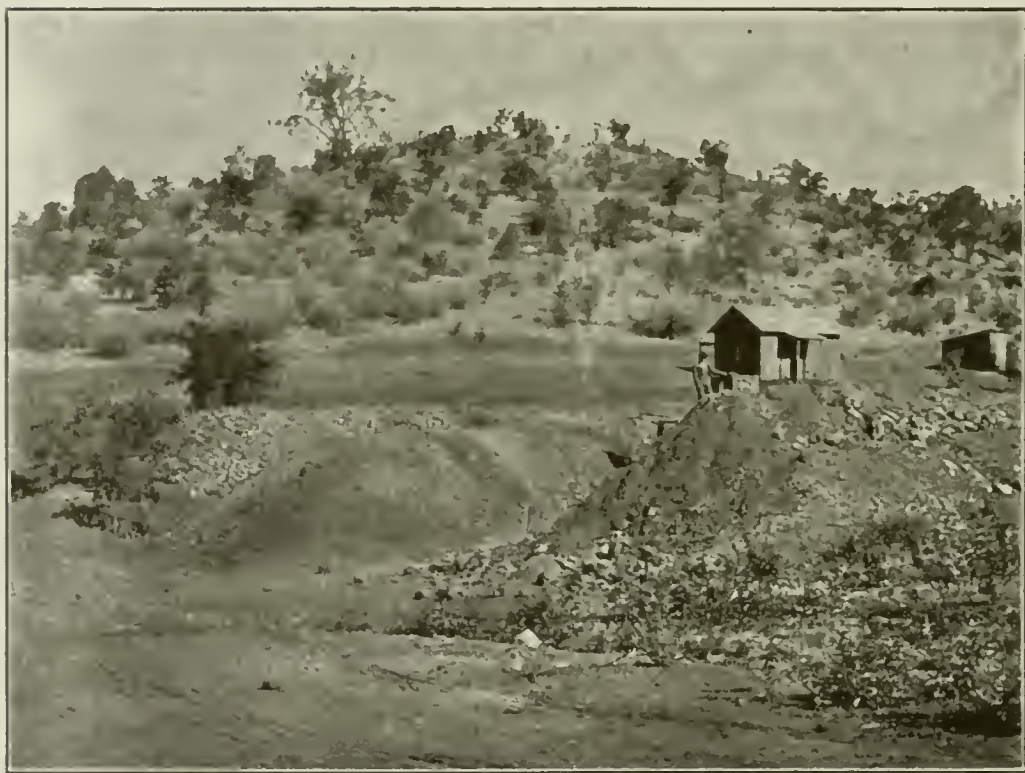
Lone Tree Mine.—Owned by H. W. Cornett; is in Sec. 2, T. 7 S., R. 15 E. Heavy gossan croppings show in several places on the claim. The inclosing rocks are a slaty schistose diabase. The only development is a shaft about 20 feet deep. This property is about seventeen miles east of Merced. The ore carries a good percentage of copper. Developing.

John Dias Mine.—In Sec. 12, T. 6 S., R. 16 E. Opened by a shaft 24 feet deep. It shows a mineralized vein 3 feet wide in schistose diabase. The vein strikes northwest. The ores are red oxide, azurite, chrysocolla, and chalcopyrite. The owners were extracting and shipping ore reputed to yield over \$40 per ton in copper and gold.

Northward from the Dias mine, the copper belt is traced up to and beyond Indian Gulch and Hornitos by prospect holes, cuts, and minor shafts. It apparently bears off a little to the east in the same manner observed in places in counties of the State farther to the north in following the bends of the grano-diorite lying to the east. After passing Hornitos, it strikes through Hunter's Valley, where there have been several important openings made and extensive mining operations carried on in years past, especially in the sixties.

La Victoria Mine.—Owned by the Coppertown Mining and Smelting Company, of San Francisco; in Secs. 4, 9, and 10, T. 4 S., R. 16 E. The company owns 7400 feet on the copper belt. The strike of the vein is in a northwesterly direction. The vein matter as explored by a tunnel is 300 feet wide; in other places it appears to be over 600 feet wide. The vein formation is schistose diabase. The character of the grano-diorite east wall here is changed, resembling diorite more than granite. The ores are green carbonate, gray copper, chalcopyrite, red oxide, azurite, and the dark bluish sulphide. Heavy gossan cappings cover all the copper ores. There is an old shaft said to be 200 feet deep in dark-colored oxide ore. A tunnel 395 feet long diagonally cross-cuts the vein formation. From this tunnel ore has been breasted out to a width of over 125 feet. Besides the above main shaft and tunnel there are many open cuts, openings, cross-cuts, and shafts, six of which average 75 feet deep. A belt of limestone a quarter of a mile wide runs parallel with the veins farther to the west and adjacent to the

vein formation. In many places the vein is blind, but the iron cappings, sometimes gossan and occasionally magnetite or black ironstone, are in line, and regular in their north and south trend. All the ores carry some gold, the gossan included. This property was owned by a French company when formerly in active operation. Three hundred men were employed in the mines, and a prosperous town of over 400 population flourished. Records show that over 2000 tons of ore were shipped via Stockton; shipping charges were \$74 per



LA VICTORIA MINE, MARIPOSA COUNTY.

ton; 2000 tons of ore were worked on the ground by roasting and leaching, and some by smelting; 200 tons of matte were produced that carried 40 to 60 per cent of copper and from \$400 to \$500 in gold to the ton. This was done in 1864 and 1865, when copper values were high. There is now to be seen a large dump of about 5000 tons of ore, said to contain 6 per cent in copper. The French company performed considerable development. At present active operations are being resumed and 14 men are employed in development. The property is a portion of the lands owned by the Pullavincini, Dulcich,

Maschio, and Enos families. The La Fayette claim is on the south end of the property and has little development.

Barretta Mine.—In Secs. 30 and 32, T. 3 S., R. 16 E.; Joseph Barretta, owner. This claim was mined in the sixties. There is now a shaft about 200 feet deep showing sulphide copper ore, reported to be rich in gold. There is a large amount of ore now on the dump. Idle.

The copper belt runs hence across the Merced River, and near it appears to branch. The west belt enters Tuolumne County through the locality of the Salambo mine, in Secs. 30 and 32, T. 2 S., R. 15 E. The eastern branch passes near Piñon Blanco (Mother Lode).

Daniel Castignetto has a claim, a quarter mile north of Barretta's, in Sec. 30, T. 3 S., R. 16 E. It shows strong gossan croppings and a vein 20 feet wide, composed of a schistose rock. The shaft is 30 feet deep, showing decomposed red, blue, and green copper ore, and is reported to assay 6 per cent in copper and to prospect high in gold. Idle.

Farrari Brothers own a claim near by that carries a fair grade of copper ore, opened by cuts, and a shaft 50 feet deep. From this claim it is reported they have recently taken out \$5000 in gold. Idle.

There is a claim about a quarter mile from the Chemisal House, whereon are two shafts sunk in the gossan, one 15 feet, the other 20 feet deep. Fair copper ore. Owner, Daniel Castignetto. This is in Sec. 31, T. 3 S., R. 16 E. Idle.

John Barfield, in Pleasant Valley, owns the Bruschi mine, opened many years ago by shafts, cuts, and tunnels. The claim runs to the Merced River, in T. 3 S., R. 15 E. Idle.

Between Barfield's and Hornitos there are copper croppings somewhat prospected, especially at about half way between the two places on Phillips Flat.

From Barfield's, across the river to the north are croppings, and on Antone Rihn's ranch, in Sec. 13, T. 3 S., R. 15 E., there are shafts 60 and 40 feet deep respectively, showing chalcopyrite, besides decomposed copper ore. On the Halstead place there are croppings and a shaft 30 feet deep, showing copper ore. The vein is 4 to 6 feet wide. The croppings are copper-stained schistose rock.

At Flyaway, about five miles southeast of Coulterville, on the county road to Bear Valley, is a claim having a shaft 75 feet deep, with drifts at bottom. The croppings of the vein are 7 feet wide. It is in the serpentine belt that traverses the country hereabouts. In the shaft the vein, carrying copper, averages 12 feet wide. The copper content has always been neglected, and the ore worked only for gold. It is reported that about \$75,000 in gold has been taken from pockets in the mine. The owner is G. Commissiona. Property idle.

In the eastern portion of the county there are indications of extensive deposits of copper ore, which have never been worked to any considerable extent. The Minarets, on King Creek, a west branch of the Little San Joaquin, on the south shoulder of Mount Lyell, exhibits strongly impregnated copper rocks. There is no development, however, to show the extent or value of the deposits.

On the north fork of Chowchilla Creek, in Sec. 34, T. 6 S., R. 19 E., at Indian Peak, considerable prospecting is being done by Mr. Ward, of Grub Gulch. Considerable native copper is found in the ores.

Copper Queen Mine.—P. Stanton and J. J. Trabucco own a claim in Sec. 19, T. 5 S., R. 19 E. It is east of the Mother Lode and about three and a half miles east of the town of Mariposa. The vein strikes northwest. A shaft has been sunk 40 feet, and an incline 15 feet deep shows a vein over 4 feet wide in a schistose formation. The ore is green carbonate on top, with blue sulphide below; some is very high grade, carrying massive native copper. Idle.

George Heiser owns an adjoining claim, showing similar ore, with shaft 30 feet deep. The values reported are from 19 to 37 per cent in copper. Idle. There is an abundance of timber surrounding the above two properties.

Copper in slate and quartz is occasionally found in localities adjacent to the Mother Lode, and on the east side of it, along its course, but such occurrences have never proved to have any economic value.

There is a minor spur from the copper belt proper in the southwestern corner of the county in Sec. 30, T. 8 S., R. 18 E. Not much prospecting has been done upon it.

MADERA COUNTY.

The foothill copper belt maintains in Madera County the importance, promise, and characteristics it displays in Mariposa County to the north. At various points through this county it exhibits strong copper-bearing veins, frequently carrying good values in gold. Here, too, were some of the important early attempts at copper mining and smelting. Before 1866, the Buchanan mine, near the northern boundary, was operated with the aid of a small furnace, and 150 tons of copper bars had been shipped. This county has also been the scene of recent attempts at mining and reduction of copper ores by the California Copper Company, though temporary failure has marked the attempt. During the past two years several copper properties have been undergoing development.

Madera County differs from its northern neighbors of the Sierra Nevada mineral belt in reaching westward past the foothills to the center of the great San Joaquin Valley, and so including in its area a large section of that fertile plain. It mainly lies on the slope, however, reaching to the summit line of the range, and possessing a wealth of minerals, forests, and waters. Though the Mother Lode and the auriferous slate belt of the slope terminate just to its north, the county includes a rich section of the Sierra auriferous belt, but the multitudinous quartz veins are in granite and other formations. There are several important gold mining districts in the county, including Grub Gulch, Fine Gold, Fresno, Potter's Ridge, and others, and a number of important mines have been developed, yet the county has been strangely neglected and its mineral resources are but slightly developed or even known.

High in the Sierras, by the Minaret Mountains, are rich silver-bearing veins, and one of the largest and richest deposits of iron ore in the United States. Difficulty of access and other conditions have kept them undeveloped. A movement to exploit the Minaret district has recently been started.

Among other mineral resources of the county is granite. The granite quarry at Raymond is one of the largest and most active in the west. The foothill mineral belt crosses the county from Mariposa to Fresno, maintaining its southeasterly course and its relative position on the slope.

Buchanan Mine.—Close to the northern boundary of Madera County, but a little south of the Green Mountain mine in Mariposa County, is the old Buchanan mine, lately re-opened on a small scale. It is in Sec. 33, T. 8 S., R. 18 E., and is now owned by G. A. Pherson. Five miles southwest is Daulton, on the branch railroad to Raymond. The mine is opened by five tunnels, respectively 500, 120, 100, 60, and 30 feet in length. There are also two shafts, each about 200 feet deep. The vein matter is diabase and amphibolite schist, both mineralized. The east wall of the diabase dike is grano-diorite. The ores are principally oxides near the surface. In depth they are the unaltered sulphides. Lessees were working the mine at the time of inspection, and were completing a shipment of one car-load of ore. This ore was reported to contain about 15 per cent of copper and about \$3 in gold per ton. There are three winzes below the 500-foot tunnel, which show the four veins from 4 to 9 feet wide. The large dumps show that extensive work has been done in times past, since the discovery of the deposits in the early sixties. What ore can be seen appears to be good both in quantity and quality. The mine is near the railroad.

On the line southeast toward the Daulton ranch house there are several openings on the belt consisting of old and new shafts, cuts, and tunnels, whereby one is enabled to trace the course of the belt unerringly.

Copper Queen Mine.—In Sec. 15, T. 9 S., R. 18 E., two and a half miles north of the Daulton house. Mr. Allinger has bonded the property and was sinking a shaft in the same formation as at the Buchanan and in the Daulton mines, and obtaining the same class of ore. Owner, the Daulton Estate.

West of the old Daulton school-house a short distance are several old shafts, showing copper ores, oxides and sulphides.

On the northern part of the Daulton ranch there are several good copper prospects.

California Copper Co.—This is a New York corporation which bought the Ne Plus Ultra and other claims on the Daulton ranch, near the railroad, in Sec. 35, T. 9 S., R. 18 E., about four years ago. The mine was developed and a 100-ton smelter was erected at Madera, twelve miles distant, in 1899—



BUCHANAN COPPER MINE, MADERA COUNTY

1900. After four months of smelting, the smelter and mine closed down in June, 1900, and have since been idle. The claims are opened by three shafts and equipped with steam hoists. The depths of the shafts are respectively 200, 200, and 120 feet. Besides these, there is another shaft on the Nelson claim 100 feet deep, equipped with a whim. The vein matter is in places 200 feet wide. The more condensed areas of mineralization are about 60 feet in width. The formation is diabase, which in places changes to talcose schist. Grano-diorite lies to the east, as is usual on this belt. The ores are carbonates, oxides, and sulphides. The two former overlie the latter and are in lens-shaped bunches. There are gossan croppings capping the ore bodies. The strike of the vein is northeast; the dip is to the east. Large quantities of ore have been extracted, shipped, and smelted. The three hoists surmount the summit of a low hill, around whose base are grouped the various mine buildings, such as bunk houses, store, offices, shops, dwellings, etc.

The smelting plant of the company is located at Madera, twelve miles west from the mines. The ore was transported to Madera by teams, from which point it was shipped by rail to one of the acid works on San Francisco Bay. The sulphur was there extracted and the cinders returned to Madera, where they were mixed with a certain proportion of raw ore and smelted into matte. This process was continued for about four months, when the smelter was shut down. While in blast they shipped, according to information, on an average one carload of matte per day. The smelter is of 100 tons daily capacity.

Questo Mine.—This is the south extension of the Daulton, and is owned by Mr. Greenwood. The vein matter is meta-diabase. The ore occurs in lenses and with good copper indications. It is now idle, although considerable work has been performed upon it.

The copper belt extends south of Daulton to the San Joaquin River, the county's southern boundary. It can be traced along this interval and its course proven by croppings, cuts, and shallow shafts, but thus far no important openings have been made into its depths. Near the Fresno River it disap-



CALIFORNIA COPPER COMPANY'S PROPERTY, DAULTON RANCH, MADERA COUNTY.

pears, but reappears farther southward. From a point ten or twelve miles directly east of Madera copper-stained rock appears continuously into Fresno County. The formation in which the masses of iron and copper sulphides occur is practically the same, viz., a meta-dabase. The grano-diorite follows along as an east wall.

In Secs. 23 and 26, T. 10 S., R. 19 E., on patented land owned by Mrs. L. Krohn, J. H. Ward was developing under bond an old claim which was originally taken up for gold. Good copper ore and indications of a deposit were observed.

Adobe Ranch.—The croppings lead into what is known as the Adobe ranch, owner C. S. Moses, in T. 10 S., R. 19 E., comprising thirty-five sections of land, and nine miles south of Daulton. There are several places on the ranch where 30 per cent copper ore is said to have been taken out.

One local peculiarity of the belt in Madera County is the presence of graphite in seams and bunches within the copper belt.

At the Fresno River there are several old shafts, the dumps of which show copper ore. The belt bears off easterly and crosses the San Joaquin at Pollasky, which is in T. 11 S., R. 21 E.

On the Chowchilla River, in the northern part of the county, in T. 7 S., R. 19 E., there is quite an extensive copper deposit, which C. M. Ward was prospecting. The ores so far developed are oxides and carbonates.

Three miles east of Bellview, in Sec. 16, T. 10 S., R. 21 E., off the copper belt, is what is known as the Old Reed mine, which carries some copper in its ores.

Big Chief.—This claim, owned by M. Lauer et al., is on the east bank of Fine Gold Creek, in Sec. 23, T. 10 S., R. 21 E., in the Hildreth mining district, on the south side of the county. Considerable development has been performed on a series of three ledges, 2 to 8 feet wide. Here the smaller veins are of quartz, in a schistose vein matter of extensive width. One tunnel is in 46 feet. There is a shallow shaft 10



CALIFORNIA COPPER COMPANY'S SMELTER AT MADERA

feet deep. The greater part of the work is against the face of the bluff, where the veins are exposed. The copper ores are sulphides, oxides, and green carbonate, and it is said that they carry values of \$4 to \$5 in gold per ton. There is over 500 tons of broken mineralized rock on the dump. Sinking was in progress on a mineralized vein of unknown width.

FRESNO COUNTY.

About 30 miles of the foothill copper belt measures the narrowest part of the large and important county of Fresno, which stretches from the crest of the Sierra Nevada range for nearly 150 miles down the Sierra slope, across the San Joaquin Valley, and up the eastern slope of the Coast Range to its summit. It thus naturally displays a very great diversification of physical features, conditions, and resources. The rugged and well timbered and watered Sierra slope, nearly 60 miles wide from range summit to valley plain, is extensively mineralized, but its mineral resources have been but slightly exploited. Gold quartz veins are plentiful along a wide belt, and several mining districts are well known, but the gold product is yet small. In few counties does the inaccessible and unexplored base-ore belt of the high Sierras display more inviting surface indications. Below these great areas is the foothill mineral belt.

The varied mineral resources of the county that have been developed are mainly in the lower foothills of both ranges. The chief feature of these resources is the petroleum of the famous Coalinga oil-field on the western side of the valley, the product of which in 1900 was about 548,000 barrels. Near this oil-field are extensive coal beds, which were at one time mined. Silver, antimony, iron, bismuth, chrome, magnesite, building-stone, and mineral waters are among the existent mineral products awaiting utilization. The Sierra slope is well watered by the San Joaquin and Kings rivers and their tributaries. The great stretch of valley plain is wonderfully fertile under irrigation, and its fruits have chiefly given the

county its fame. Here is the great raisin district of the State. One of the important electric transmission plants of the State finds its source of energy in a Sierra stream.

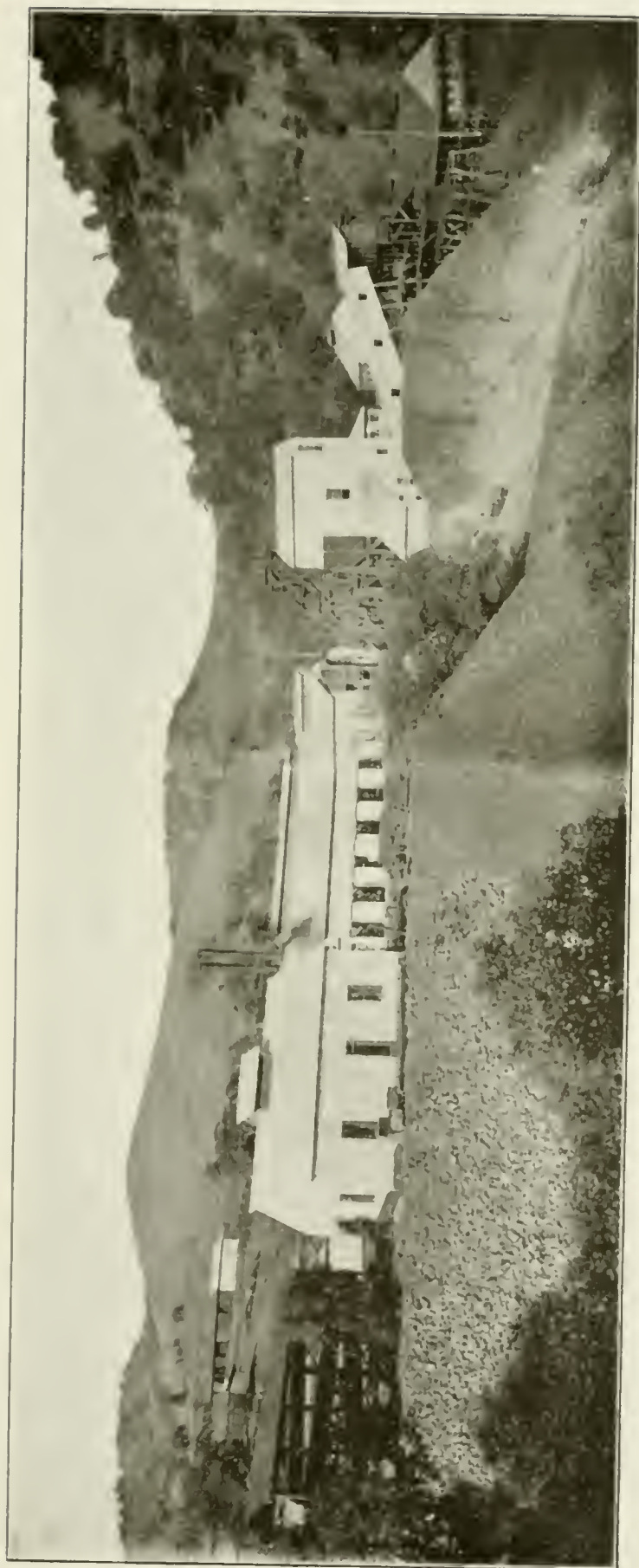
The foothill copper belt, as it enters the county from Madera on the north, displays a greater width than in any of the other counties traversed by the belt from its far northern end. The copper deposits that have undergone any development worthy of note are all near the northern side of this part of the county, and are chiefly in T. 12 S., R. 21, 22, 23, and 24 E., M. D. M. The belt here appears to display parallel lodes, spread over a width of perhaps twenty miles, and is generally taken by those locally familiar with it to divide into two branches in this region, these widely diverging branches continuing separately on through Fresno and Tulare counties. The property best known, by reason of its operations and its large capitalization, is the Copper King, which has been extensively developed and which has for some time been a producer. Most of the other properties commanding attention as prospects are within a few miles of the Copper King. A branch railroad to Pollasky runs within a few miles of this copper district near the northern side of the county. Most of the cupriferous veins of Fresno County carry gold, as do those in Madera and Mariposa to the north. Far east of the belt, and high in the Sierras, at altitudes of several thousand feet, are various mining claims covering veins superficially rich in copper and gold; but, like the rest of the mineral riches of this vast region, they await the more favorable conditions that time will bring to an almost inaccessible country.

Painter Mine.—This property, by the northern boundary, near Pollasky, in Sec. 33, T. 11 S., R. 21 E., is owned by the Imperial Copper Mining Company. The course of the vein is 23 degrees north of west. There are gossan croppings 1 to 20 feet wide. The vein matter is meta-diabase, changing in some places to talcose schist. The country rock is diabase and amphibolite schist. The vein followed in the workings is from 4 to 7 feet wide. The mine was re-opened in 1900. The development consists of one shaft 110 feet deep, equipped with a horse-whim, which shaft follows oxidized ores for 100 feet, and then encounters the sulphides. An inclined shaft 80 feet

deep follows the hanging wall. This shaft has drifts and cross-cuts from it, with total lengths of 160 feet. Another shaft has been sunk 50 feet in carbonate ore. There is an open cut 6 or 7 feet deep, made in 1866, that follows the vein about 50 feet, and shows good appearing oxidized ores. The known length of ore shoot disclosed by the above openings is 750 feet. In places in the mine there are found lumps of very rich ore ("nigger heads"), inclosed in talc. From the first shaft drifts extend both east and west for 45 feet, making a total drift length of 90 feet. Several hundred tons of ore have been extracted and shipped, and is said to have yielded an average of 15 per cent copper. The copper belt at this point is two miles wide. The Painter mine is on the east side and the Heiskell mine on the west side of the belt. There are a few buildings on the property, such as assay office, boarding and bunk houses, barn, etc. The mine is now idle.

Fresno Copper Mines.—This group, formerly known as the Heiskell, consisting of five full claims, is owned by H. B. Vercoe et al., H. G. Vercoe superintendent, and is in Sec. 10, T. 12 S., R. 21 E. The course of the vein is north and south, width 18 feet. There are heavy gossan croppings. The gossan extends downward about 50 feet. Below these gossan caps are bluish-black sulphides. The mines are opened by shafts, two of 200 feet each in depth, one of 50 feet, one of 45 feet, and one of 35 feet. Six men were employed. The ores are carbonates and oxides above and sulphides below, and the average assay value of the ore was stated to be 7 per cent copper and \$2 in gold.

Copper King Mine.—This mine is in Sec. 3, T. 12 S., R. 23 E. It is owned by the Copper King Mining Company, Ltd., of London, of which W. H. Daily is the general manager. The property consists of one mining claim, 1500 by 600 feet, with all necessary buildings thereon. The vein courses northeast and southwest. That portion of it now being worked is from 2 to 19 feet in width. The vein matter, however, appears to have a width of over 100 feet. It is schistose and meta-diorite in its composition, all mineralized. The lenses of ore consist of carbonates, oxides, and sulphides of iron and copper. The sulphides obtain to the exclusion of the others in the deeper



MINING PLANT OF THE COPPER KING MINING COMPANY, LIMITED FRESNO COUNTY

workings of the mine. This is opened by three shafts, the deepest of which is used for operating purposes and the others for ventilation only. The first named shaft is 450 feet deep. From the 400-foot level a winze is being sunk, and in August, 1901, was down 30 feet below the level. Altogether there are six levels driven from the operating shaft, with total lengths of over 2500 feet. As said, the ore bodies are in the form of lenses. The usual grano-diorite belt bounds the copper belt to the east and diorite lies to the west.

After the ore has been hoisted, crushed, and sampled it is conveyed seventeen miles in traction wagons to a siding on the Southern Pacific railway, called Deering. Thence it is transported to the company's smelter, at Seal Bluff Landing, on Suisun Bay, near Martinez, and there reduced. Power for all purposes at the mine is generated in a battery of boilers by crude petroleum, transformed into electric energy by a compound engine and large generator, and distributed to the hoist, crusher, belt conveyor, and sampling machine. There is besides this plant, a steam air-compressor for operating the drills in the mine. The buildings about the mine are good and ample. An automatic system of sampling goes on during the time the ore-bins are being filled with crushed ore. The residual sample is assayed, and average value of the contents of each bin is thereby shown. From these bins the fine ore is subsequently passed to square iron tanks on the traction wagons. Each wagon has four bins, together holding more than 33 tons of ore. Three trains drawn by traction engines make one trip a day to Deering, and thus daily deliver 100 tons of ore to the cars bound for the smelter. At present, the hoisting equipment is equal to raising 200 tons per twenty-four hours. Water for all purposes at the mine is derived from springs and from the mine itself. Seventy men are employed about the mine and station. The general manager stated that the average amount of copper contained in the shipping ore was about 7 per cent.

The smelter of the Copper King, Limited, at Seal Bluff Landing, on Suisun Bay, is forty miles from San Francisco, and is called the Pacific Coast Smelting and Refining Works. The location affords both rail and deep-water transportation facilities. The plant has been in full operation but a few months. Extensive buildings and modern facilities of con-



SHIPPING STATION OF COPPER KING, LIMITED, AT DEERING, ON S. P. R. R.



SMELTER OF THE COPPER KING, LIMITED, AT SEAL BLUFF LANDING,
CONTRA COSTA COUNTY.

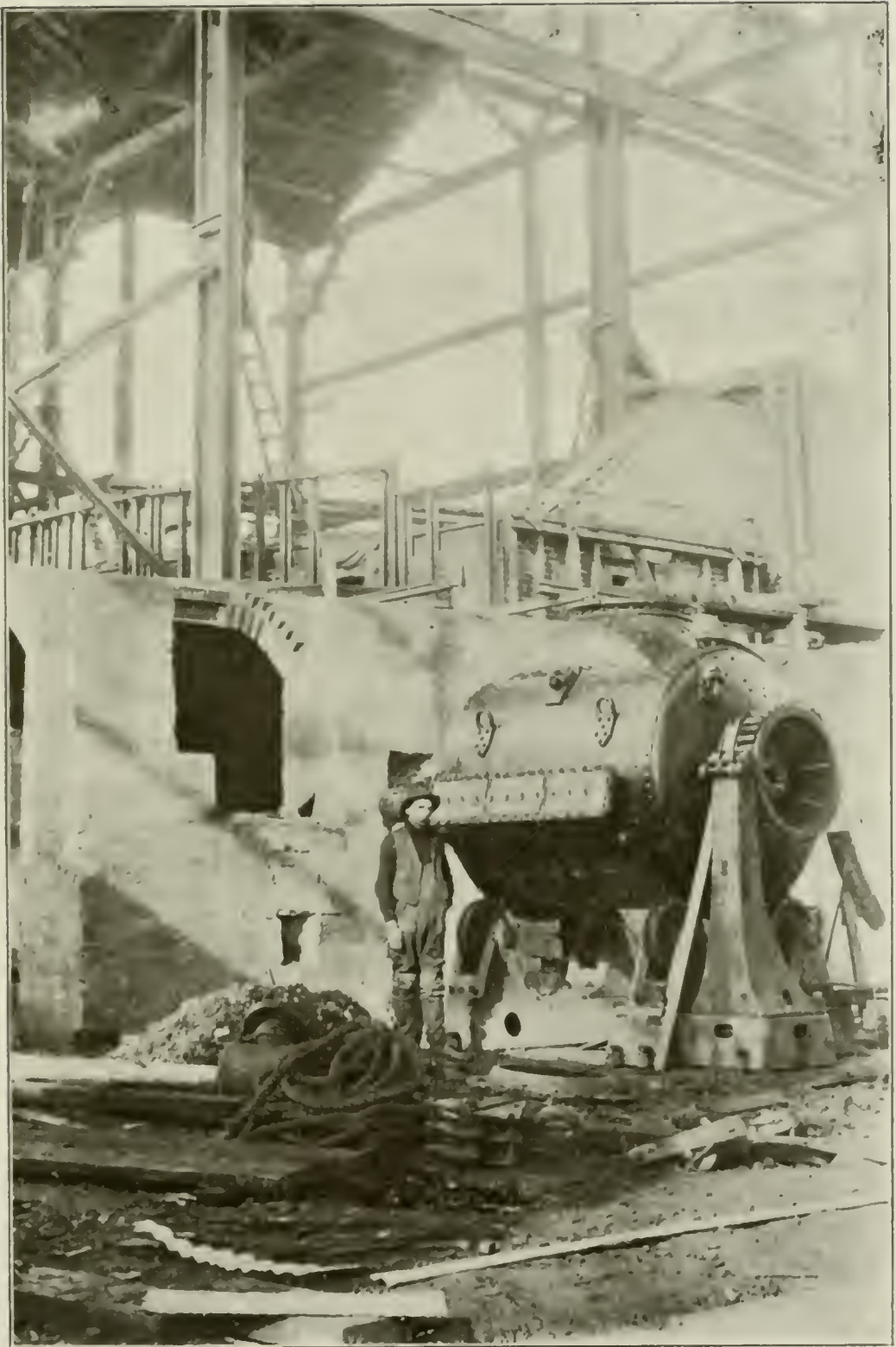
venient arrangement have been erected. Electric power generated on the premises with oil fuel is used. The ores are classified upon their arrival at the smelter. After passing through a No. 3 Gates crusher, the ore is conveyed by a bucket elevator to the rolls and trommel. From the trommel the ore goes to two 50-ton MacDougal roasting furnaces. In these furnaces no fuel is required, the burning sulphur in the ore supplying the necessary heat. From the roasting furnaces the ore goes to a 100-ton reverberatory furnace and is converted into matte. In this furnace crude petroleum is used for fuel. From the reverberatory furnace the matte is tapped immediately into a converter, where it is made into blister copper. The converter slag, carrying 7 to 8 per cent copper, is returned to the reverberatory. Additions to the plant, including blast furnaces, are now being made, and when completed the daily capacity of the plant will be 300 tons. Besides treating the ore from the company's mine in Fresno County, copper ores are sought and received from many sources.

Wabash Mining Co.—This company has located ground surrounding the Copper King mine on all sides. There are two shafts on this property, one about 40 feet deep, on which the owners were making preparations to erect hoisting machinery. The other shaft is over 30 feet deep. One tunnel has been run over 400 feet, and another 300 feet. The vein formation is similar to that of the Copper King. These mines may be described as now being in the stage of early development. They are in Secs. 2, 3, 10, and 11, T. 12 S., R. 23 E., and are owned by Dr. Bryant and others of Los Angeles.

Mount Sterling.—Owned by Kneiper & Ashbrook, and adjoining the Wabash ground on the south, in Sec. 10, T. 12 S., R. 23 E. On this property the owners are driving a tunnel to cut the ledge, which is mineralized, carrying iron and copper sulphides. Developing.

Grubstake Claim.—Owned by C. H. Kneiper and — Taylor; adjoins the Mount Sterling, and shows similar copper ore. Developing. Southward, the indications of copper ore continue to Kings River.

Black Mountain Claim.—In Sec. 36, T. 11 S., R. 23 E., one and a half miles northeast of the Copper King; owned by W. S. Cranmer. It is on patented land. The vein is in lime-



CONVERTER FURNACES, IN COURSE OF ERECTION, COPPER KING, LIMITED,
SEAL BLUFF LANDING, CONTRA COSTA COUNTY

stone (calc spar), and averages about 3 feet in width. This ore is said to carry 15 to 19 per cent copper and \$5 in gold per ton. The openings comprise a shaft 30 feet deep, a tunnel run in a northeasterly direction along the course of the vein for 60 feet, and another tunnel 20 feet below the first named, following the vein for 180 feet. The vein splits and has decidedly branching tendencies. At the mouth of the 180-foot tunnel there is a shaft 30 feet deep in ore. A third tunnel, intended to strike the vein 100 feet below the bottom of this 30-foot shaft, has been started. It is now in 125 feet. Open cuts and shallow holes on the surface discover the same quality of ore wherever they have been sunk. The ore is oxide and sulphide of good appearance. The east wall is a gray diabase, associated with talc schist. Idle.

Buck's Peak Claim.—Two miles south of Black Mountain; owner, W. S. Cranmer. Shows two veins, 30 feet apart, one of which is one foot wide and the other three feet wide. A shaft 12 feet deep on the 3-foot vein shows green carbonate of copper ore for the whole width of the vein. Idle.

Sunset Mine.—In Sec. 35, T. 11 S., R. 23 E.; owners, D. S. Snodgrass et al. There are gossan croppings. The ledge matter is 60 feet wide. The ore is of about the same character as that in the Copper King, and consists of carbonates and sulphides. There is a shaft 90 feet deep, with cross-cut at its bottom 60 feet long, all in ore, which is said to average 10 per cent copper and to carry about \$14 in gold per ton. The vein matter is schistose diabase. A belt of limestone occurs in the east side. Idle.

A. L. Hildebrand has locations on both the north and south ends of the Sunset claim. On these locations are croppings of the same character as on the Sunset. Very little development. Idle.

Henry Wineberger has locations on the northwest side of Hildebrand's claim, on which there are indications of copper. Idle.

Happy Camp Claim.—Three and a half miles east of the Copper King mine. There is a tunnel 135 feet long, with cross-cut at end 17 feet long from wall to wall. The ore is decomposed quartz, said to carry 4 per cent copper and \$10 in gold. Idle.

W. L. Hinkle & Bros. have some claims in Secs. 25, 26, and 27, T. 12 S., R. 24 E., that show copper ore in talcose schist. There are several other prospects near by, which yield copper minerals.

Anderson & Gist own fifteen claims on Hog Mountain, one and a half miles west of Trimmer Springs, in Secs. 14, 15, 23, and 24, T. 12 S., R. 24 E. Across the river east of Trimmer Springs, Mr. Terrill of Visalia is working ten claims in Secs. 16 and 17 on the copper belt, with some favorable prospects. These claims are in T. 12 S., R. 24 E. There are heavy iron gossan croppings on the property.

In Kings River Cañon, high in the Sierras, in Secs. 9 and 10, T. 13 S., R. 31 E., there are indications of copper deposits. George Badders & Co. are now working seven claims, in which they find some very good oxide and sulphide ores. They had opened a shaft 30 feet deep, but not enough development work had been performed to determine the extent or value of these deposits. The vein matter is mostly quartz.

P. A. Kanawyer & Sons own a group of eight claims in Sec. 11, T. 13 S., R. 31 E. The vein matter is quartz, with grano-diorite walls. The vein shows 6 to 15 feet in width, and is traced for two miles. It carries, according to information, over 10 per cent copper and \$11 in gold. There are open cuts and a perpendicular cliff 100 feet high; the cliff shows the vein in its face. The prospect is thirty-six miles from Millwood. Developing.

TULARE COUNTY.

A large area of the Sierra slope is comprised within the bounds of Tulare County, the eastern boundary of which runs for about 75 miles along the range summit and the western portion of which embraces a fertile and favored section of the San Joaquin Valley. In this county, in the Sierra foothills, is one of the important orange districts of California, and here, also in the valley plain below, are extensive orchards and vineyards as well as many great grain ranches. This is one

of the minor mineral counties of the State, though it has extensive mineral resources awaiting the future.

In this county, the copper belt displays but occasional indications of its presence, has been but little explored and only slightly developed. The branches into which the belt divides in Fresno County appear to be prolonged, with increasing divergence, through Tulare County. The western branch is the most clearly defined, and is characterized by narrow diverging seams or stringers of copper-bearing minerals. Just east of Porterville, there is an area of country fully five miles wide, in which these small veins occur. Like the eastern branch this one is extensively hidden by detrital deposits, and outcrops only at intervals. This west branch appears to lose its identity and disappear near Kernville, in Kern County, to the south. The east branch of the belt swings easterly and mounts to an altitude of over 5000 feet. The chief deposits identified with this east branch are near the middle of the county, thirty miles or so east of Porterville and the west belt, and amid the forest region, where some of the chief sequoia groves of the State are found. Copper prospects of possible future value occur high in the Sierras, notably some described below, located close to Kearsage Peak in the extreme northeastern corner of the county, above the timber line and at an altitude of 10,000 to 12,000 feet.

W. F. Powell owns some claims in the east branch of the copper belt, located in Sec. 30, T. 19 S., R. 31 E., on the middle fork of Tule River, thirty miles east of Porterville, at an altitude of about 5500 feet. The mineralized zone is said to be 300 feet wide, and can be traced by surface croppings for more than six miles in a northerly direction. There are three tunnels, one cross-cutting the mineralized rock for 150 feet, without reaching a wall. The course of the vein is northeast and southwest. The copper ores are yellow and black sulphides, carrying 3 to 4 per cent copper. Occasionally, however, small quantities of native copper are found. The vein matter lies between a limestone east wall and a serpentine west wall.

W. F. Grider has a claim two miles east of the Enterprise sawmill, in Sec. 31, T. 19 S., R. 31 E. Some test lots of ore have recently been shipped.



COPPER MOUNTAIN MINING COMPANY'S CLAIMS, TULARE COUNTY.

C. W. Keller owns claims near Powells, in the same township and range. The vein matter is reported to be not less than 70 feet wide on any of these claims. A lime belt 4 to 100 feet wide intersects the copper lode near these places. The copper belt crops out again strongly five miles above Three Rivers, and there are several locations on this part of the belt.

East of Porterville, ten miles, in Sec. 14, T. 23 S., R. 28 E., Dr. Barber, of Porterville, prospected what proved to be a blanket, or slide, of ore carrying 8 to 37 per cent copper. Idle.

Dr. Barber also has a claim located eight miles east of Porterville, in Sec. 19, T. 21 S., R. 29 E. Undeveloped to any great extent. Here there is a heavy iron capping, and the vein appears to be 20 to 30 feet wide. Below the iron cap carbonate and oxide of copper ore is found. The formation is diabase and amphibolite schist. The gold content is reported at from \$3 to \$4 per ton.

Dewey Claim.—Owned by J. F. Boller, of Porterville, is in Sec. 32, T. 19 S., R. 31 E. Only a small amount of development has been performed. This exposes sulphide ore. Idle.

On the hillsides east of Porterville is an abundance of small pieces of copper float, which doubtless came from the five-mile belt of small stringer veins spoken of.

Copper Mountain Mining Co.—Owns fifty claims in Secs. 34 and 35, T. 14 S., R. 31 E., near Kearsarge Peak, close to the crest of the range. R. McCourt is superintendent, and J. B. Campbell, of Fresno, president. The mines were opened in July, 1900. The ores are sulphides and carbonates, carrying from 2 to 25 per cent of copper. The mineral-bearing belt is a mile wide, and courses northeast and southwest. The deposit in the richer veins of this belt are opened by a shaft 18 feet deep, a tunnel 15 feet long, and an open cut 50 feet long, on the east side of Roaring River. On the west side there is an old shaft and drift, shaft 30 feet deep. Developments were in progress.

At the head of Cloudy River Cañon, close to the Copper Mountain property, there are some cuts, and a tunnel 40 feet long. Quartz shows strongly in this tunnel. The decom-

posed ironstone carries gold. The old shaft shows a 3-foot ledge of carbonate ore. The vein matter is schist, diabase, and amphibolite. The claims are 1000 feet above the timber line. A dike about 3000 feet wide passes through the summits of the mountains. This dike is of mineralized rock. Twenty-five men were employed in development work.

KERN COUNTY

The foothill copper belt terminates in a vague way in Kern County, where a few groups of copper deposits cut a small figure among the varied mineral products of a great mining county. This is one of the large counties of the State, having an area of about 8100 square miles, and it is characterized by greater variety and contrasts of topography, geology, climate, and resources than any other county of the State.

Its eastern and southern parts contain the southern end of the Sierra Nevada range and its mergence with the Coast Range at Tehachapi. Its western boundary is along the summit of the Coast Range, and the upper end of the San Joaquin Valley makes up about one third of the county's area. The southeastern slope of the Sierras and a large portion of the Mojave Desert are included in its southern part. The county thus includes slopes of two mountain ranges, a large and fertile valley plain, and an arid desert region. All of these contrasted regions contain much mineral wealth. On the Sierra slope, amid forests and waters, are important quartz mining districts. In the valley plain, near Bakersfield, is the remarkable and widely known Kern River oil-field. On the eastern slope of the Coast Range are the Sunset and McKittrick oil-fields, which help make Kern the preëminent petroleum-producing county of California. The foothills of both these ranges abound in various minerals, including gypsum and antimony. In the desert region of the county is the Randsburg district, one of the chief gold fields of the State, and other gold districts are undergoing development on the desert side of the Sierras. The mineral output of the county in 1900 was \$1,867,856, of which \$805,252 was in gold. In the San Joaquin

Valley are extensive orchards and the largest irrigation systems in the State. The Kern River, of the Sierra slope, furnishes power for one of the important electric power transmission plants of the State.

The copper occurrences are so few and widely separated, as far as discovered, that one is hardly warranted in identifying them with the copper belt, except in the most general way. The continuity of the belt is less apparent than in any of the counties of the slope to the north. Copper deposits have attracted attention principally in three localities: Near Woody and quite a distance east near Kernville, on the western Sierra slope; in the Rademacher mining district, on the southeastern slope of the Sierras; and on the northern edge of the Mojave Desert, north of Randsburg. In the neighborhood of Walker's Pass, between Kernville and the Rademacher district, copper minerals are found, and the copper claims of the latter district may, perhaps, be appropriately classed with the Sierra Nevada deposits rather than with those of the arid portion of Southern California.

Greenback Copper Mine.—Located in northern Kern County, about thirty-five miles by wagon road from Bakersfield and about eighteen miles due east of Jasmin, on the Porterville branch of the Southern Pacific Railroad. The property of the Greenback Copper Company consists of Secs. 1 and 3, and the southern part of Sec. 2, T. 26 S., R. 29 E., embracing in all 1520 acres. The mine lies on a slight elevation in a basin, the rock forming which is grano-diorite. The granite is intersected by a parallel system of joints or fractures, which usually trend approximately east and west. In addition, there are very abundant dikes of a white, fine-grained granite (aplite) in the coarse granite or grano-diorite. They are from a fraction of an inch to 10 feet in width. There are also white, coarse, pegmatite dikes, or veins in the granite, and some of these are developed sporadically as bunches of white quartz ("bull" quartz). Copper has been found at a number of points in the neighborhood, and the lodes are usually more or less parallel to the structure planes of the inclosing rocks, but this is not the case with the Greenback lode, the general trend of which is across the east-west fracture system of the grano-diorite. About one mile

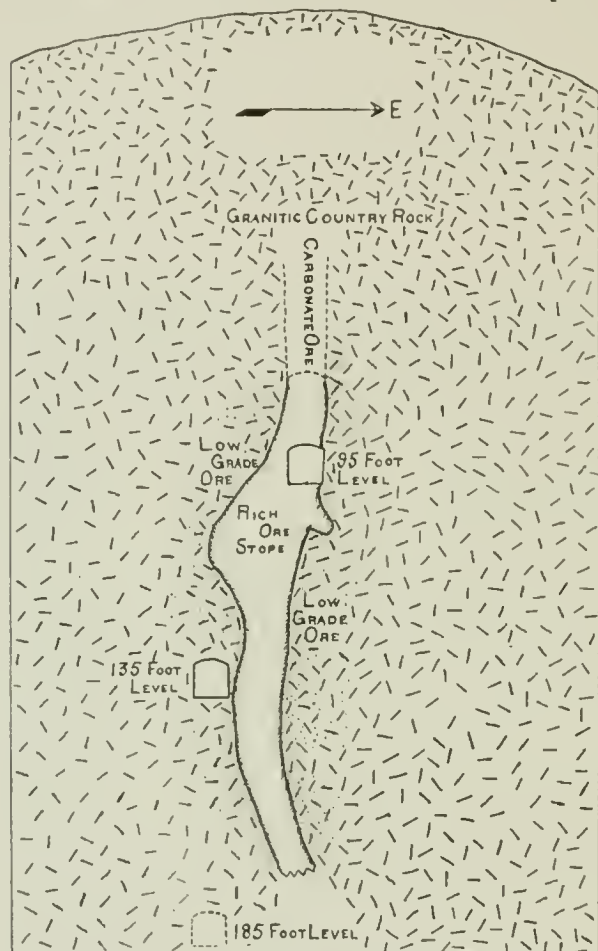
southwest of the mine lies a high east-west ridge known as Iron Mountain. The upper part of this ridge is composed of a variety of rocks, some of which strongly resemble quartzite, but the slopes of the mountain are all of granitic rocks. There are several cuts and shafts on the top of the mountain in the hard quartzite-like rock, but no strong indications of copper appear to have been found, except on the north slope, just west of the line of section 3, and on the south slope of the east end of the mountain, where some work is now being



GREENBACK COPPER MINE, KERN COUNTY.

done on a copper lode. Several claims are located on this lode. At most of the points where copper has been found, the lode at the surface is composed of a gossan of rusty iron-stained material, often apparently rotten granite, generally somewhat gneissic and not always showing copper carbonate. The croppings of the Greenback lode consist of altered granite, decomposed, and impregnated with iron oxide and at some points with copper carbonate, and there is more or less quartz mixed with it. The Greenback lode has been opened by a shaft which inclines to the north about 60 degrees, and from

this shaft three levels have been run to the north, which are vertically below the croppings, respectively, 95, 135, and 185 feet. The upper part of the main ore shoot is composed of carbonate ore, and has not been stoped out; but from a point



VERTICAL SECTION THROUGH STOPE IN GREENBACK COPPER MINE.

about 65 feet below the croppings to a point 170 feet below, this ore shoot has afforded nearly all the ore that has thus far been shipped, the reported average contents being 5.7 ounces of silver and 19.4 per cent of copper per ton. As seen in the cross-section, the ore shoot is lenticular in form, with a maximum width of about 20 feet. Outside of this ore shoot the granite is irregularly impregnated with copper pyrite, so that there is a much larger amount of lower grade ore in the mine

than of shipping ore. The Greenback lode does not appear to show any well-defined fissure. While there are walls and seams along which movement has taken place, and these usually have a trend to the east of north, yet these walls and seams appear to dip both to the east and west at high angles. As indicated by the croppings, the lode may be said to have a length of perhaps 350 feet measured from the south base of the dump to the old shaft on the top of the hill. The position of the new 185-foot level is shown in the cross-section, but there is no data at hand as to the width or grade of the ore body on this level.

A. J. Maltby owns two claims in Secs. 4 and 10, T. 26 S., R. 29 E. Here there are gossan croppings and schistose-

diabase vein matter, as well as talcose schist. There are open cuts exposing ore. Two shafts, 16 and 35 feet deep, are in ore. There has been shipped some ore said to average about 6 per cent in copper and a small amount of gold.

The Spa and Bonanza claims, in Secs. 3, 4, 9, and 10, T. 26 S., R. 29 E., show copper ore reported to average from 15 to 20 per cent. There are four shafts on these claims. On section 9 heavy ironstone croppings can be traced for considerable distances. Idle.

South of Kernville, in T. 26 S., R. 23 E., J. L. Hooper is making developments that show some copper.

J. R. Manning of Randsburg is one of the owners of a group of copper claims in Secs. 7, 18, 19, and 30, T. 28 S., R. 40 E., and in Secs. 12, 13, and 24, T. 28 S., R. 39 E., in the Rademacher district near the eastern county boundary, in the Mojave Desert. The belt here is one and a half miles wide. Grano-diorite lies contiguous to the east, and on the west there is a lime belt. The lode is formed of a mineralized meta-diorite schistose, changed in part to talcose schist. The seams of richer copper ore run from 2 to 12 inches in width, and where they form lenses or "shoots" they have widths occasionally of 60 feet. These lenses of highly mineralized rock constituting the ore carry a good percentage of copper. Development was in progress.

Near the Manning claims is the Gallow Glass group, in which the gossan croppings are 60 to 100 feet wide and the magnetite from 5 to 15 feet wide. There are thirty-seven mining locations on this part of the belt. There are several open cuts, one shaft 54 feet deep, and fourteen other shafts from 6 to 12 feet deep. The belt can be traced by croppings and cuts for four miles in a northwesterly direction to where it disappears under the detritus of the desert. The line of demarcation between the lime and copper belts can be noted for miles. There is no available fuel at hand, but six miles to the southwest there is an extensive vein of coal now being worked. Water in abundant quantities can be obtained by sinking shallow wells in a wide area of this country.

The road from Randsburg to the south fork of the Kern River through Walker's Pass diagonally crosses the copper belt, which also crops in T. 27 S., R. 38 and 39 E.

SOUTHERN AND EASTERN DEPOSITS.

MONO COUNTY.

About 100 miles of the eastern slope of the Sierra Nevada range stretches through Mono County, which lies between the jagged crest of the Sierras on the west, Nevada on the east, and Alpine and Inyo counties on the north and south respectively. The county displays high ranges parallel with the Sierras and is a part of the Great Basin. The county is a rugged, arid, almost treeless region, remote from railroad communication, except in the southeastern corner, which is traversed by the Carson & Colorado Railroad. Mono Lake, which has no outlet, is a large expanse of saline waters. There are many thermal springs, and widespread evidences of volcanic and glacial action.

The county is richly mineralized, and has produced many millions in the precious metals. In 1900 it yielded \$670,200 in gold and \$75,921 in silver. It has a number of well-known mining districts, particularly the famous Bodie District, in which quite extensive mining operations have been conducted in the past; but the conditions above noted, the base character of the ores, and some large mining failures, consequent on incompetent or dishonest administration, have worked a long repression of the industry. The extent and richness of the mineralized veins make it certain that the future will see Mono one of the leading mineral-producing counties of the State. The base ores that fill the mountain slopes very frequently carry copper in association with other minerals, and some attempts at mining copper have been made in the past and abandoned. One small copper smelting plant produced \$60,000 worth of ingot copper many years ago. Only two copper properties attract present attention as such. They are on Copper Mountain 16 miles southwest of Bodie, and about 4 miles from the west shore of Mono Lake. The nearest railroad station is 60 miles from Copper Mountain, at Hawthorne, Nevada, on the Carson & Colorado Railroad.

Santiago, Cuba, and Havana Claims.—Owned by E. M. Cavin, of Bodie. Located on Copper Mountain. They have been developed to some extent by a 150-foot shaft, showing good ore, and by about 500 feet of tunneling, but this last work was not done to advantage. The deposit is found on the contact of limestone and porphyry. The ore is principally cuprite and malachite. The width of the deposit has not been determined. A small furnace was once erected and some ore treated, but the property is idle at present. Water power is available, and there is an abundance of timber in the region.

Goleta Consolidated Mines.—The Goleta mines are also on Copper Mountain. Hugh W. Nelson, of Jordan, is superintendent. This group is primarily a gold mine, but there is in it a copper ledge which is exposed on the hanging wall side of the gold ledge. Developments have exposed a vein of copper ore averaging 6 feet in width, the ore appearing to be chrysocolla. There is a tunnel 200 feet on the vein, tapping it 300 feet below the outcrop. The copper is not being mined, as the mines are at present worked only for the gold and silver. The ore is treated by the cyanide process, a 40-stamp mill being used to crush the ore. Water power is used.

INYO COUNTY.

Inyo County is a great and picturesque expanse of desert, 10,000 square miles in extent, lying between the summit of the Sierras on the west, Nevada on the east, Mono County on the north, and San Bernardino County on the south. On its western boundary rises Mount Whitney (14,515 feet), the highest peak in the United States proper, and about 75 miles eastward lies Death Valley, the lowest part of which is over 400 feet below sea-level. At the foot of the Sierra range is Owens Lake, fed by Owens River and having no outlet. Soda is largely produced from the waters of this lake. Practically all the arable land is comprised in a strip of bottom land, 2 to 3 miles wide, through Owens River Valley, which has a width of 8 to 10 miles. The Carson & Colorado Railroad, running

southward to Keeler on Owens Lake in the west-central part of the county, largely relieves the handicap of remoteness from which the county suffers.

Lack of fuel, water, facilities for communication, and convenient sources of supply join with an unfavorable climate to repress the mining industry generally throughout the southwestern desert region, but the great extent and frequent richness of the mineral resources of Inyo County have made it one of the important mining counties of the State since early days. The Panamint, Argus, and Inyo ranges and some lesser ones run parallel with the Sierras through the southern part of the county, and from the ledges that fill them the bulk of the \$12,000,000 worth of precious metals Inyo has produced has come. Some of the rich mines of the west were operated in various well-known districts years ago. The ores of this region are base and a large percentage of silver accompanies the gold, while lead, copper, and other metals are also characteristically associated with the precious metals. This county has been the chief silver producer of the State, and the drop in the price of silver was the main cause of the quietude of the mining industry here in recent years. During the past two or three years much active development has followed several large investments, and here, as elsewhere through that desert region, prospectors have again turned numerous to a field full of great possibilities. The expected provision of railroad facilities through the southern portion of the county will afford another great stimulus to mining activity, as heretofore only high-grade ores could be worked. The precious metal output in 1900 was \$213,655 in gold and \$113,493 in silver. In Death Valley is one of the chief borax fields of the United States. Marble of fine quality is among the mineral resources awaiting favorable conditions, and extensive deposits of nitrate of soda have been found.

There are numerous occurrences of copper, generally in association with greater values in other metals, but it is occasionally the predominating metal in ore bodies. Some copper ore carrying gold and silver was smelted to matte and shipped via the Colorado River in early times, but the copper output has been small. With cheaper fuel and transportation facilities modern smelting plants will be established in this

region and then copper will likely again figure in Inyo's mineral output.

Wisconsin Claim.—This prospect is located about a mile southeast of Darwin, and is owned by Charles Richardson of Darwin. The vein is a contact between limestone and granite. The ledge varies from 2 to 6 feet in thickness and is exposed on the surface for several hundred feet. There is a shaft about 150 feet deep, with good ore in the bottom. The ledge shows malachite, chalcopryite, and cuprite, carrying some gold and silver. The nearest point to a railroad is Keeler, twenty-four miles distant. Developing.

Kingman Claim.—James McDonald of Darwin, owner. There are two claims located one mile southeast of Darwin. The ledge is a contact vein between limestone and granite, and the average width of the vein is about 3 feet. There are two tunnels, each in about a hundred feet. The ledge shows malachite, chalcopryite, and cuprite, carrying some gold and silver. Developing.

Ubehebe District.—The Ubehebe copper belt is located about thirty-five miles east of Keeler, the terminus of the Carson & Colorado Railroad. There are about eighty claims, located within a radius of six miles. The ore is found in contact veins, between granite and limestone. There appears to be two contacts, an east and a west, and these contacts can be traced for twelve miles at altitudes ranging from 3000 to 6000 feet. The ores are in limestone. Carbonate ore (malachite) apparently prevails, although gray copper, cuprite, chalcopryite, bornite, and native copper are abundant. The ores have also gold and silver values. Owing to the fact that the ore bodies are in limestone, and that the deposits are situated in a locality where water is not encountered in mining exploitation, it is probable that the malachite will continue to prevail even as the depth increases. Assessment work has been performed and some development, with a result most encouraging.

Navajo Chief Claim.—Owners, W. T. Grant of Olancho and George McConnell of Independence. It is located one quarter of a mile south of Dodd's Springs. Elevation, 4000 feet. The vein outcrops for about 1000 feet, showing an average width

of 50 feet, and with a strike north; dip 80 degrees east. The hanging wall is limestone and the foot wall granite. The ore is chiefly malachite, carrying some gold and silver. There is sufficient water for mining purposes. The nearest railroad point is Keeler, thirty miles distant.

Eureka Claim.—Owned by Jacob Stininger; postoffice address, Tule Cañon, California. It is located one eighth of a mile south of Dodd's Springs; elevation, 3500 feet. The strike of the vein is north, and dip 60 degrees to the east. The crop-pings show a length of 150 feet, and an average width of 5 feet. There is an 80-foot shaft and 100 feet of drifts on the vein. The ore is malachite and shows some galena.

Trail Claim.—Owners, W. T. Grant of Olancha and George McConnell of Independence. It is located at Dodd's Springs; elevation, 3900 feet. The vein has a strike north; dip 70 degrees to the east. It outcrops about 800 feet, and shows an average width of 5 feet.

Dodd's Springs Claim.—Owned by W. T. Grant of Olancha and George McConnell of Independence. This mine is located on the same ledge as the Trail claim. It outcrops for 1000 feet and shows a vein about 15 feet wide. The character of the ore is malachite.

Ulida Group.—This group includes eight prospects: The Ulida, Sorbia, Sardine, H. M. Stanley, Kabba Riga, Virginia, Maryland, and Hunter, located in the Dutton range, three miles north of Hunter Ranch Mountain, and thirty-five miles east of Keeler. Elevation, 6000 feet. The nearest water is three miles distant, and could be obtained by gravity. All of the veins are contacts between limestone and granite. The ore, which occurs mostly in the limestone, is malachite, tetrahydrate, and cuprite, carrying gold and silver. Immense outcroppings, varying from 10 to 20 feet in width and showing malachite, are exposed.

At the Ulida there is a tunnel 150 feet on the vein, and another tunnel above, 150 feet long, runs for 40 feet on the vein. There has been some stoping done, and about 400 tons of ore are on the dump. The ore is sorted, packed out on mules seven miles to a road, then hauled to Keeler and



CROPPINGS OF COPPER KING MINE, UBEHEBE DISTRICT, INYO COUNTY



COPPER CROPPINGS AT DODD'S SPRINGS, UBEHEBE DISTRICT, INYO COUNTY.
(247)

shipped to the smelter. Developing. Owners, Spear Bros. and William L. Hunter; postoffice address, Lone Pine, Inyo County.

Adjoining the Ulida group on the northeast are the Keeler, the Olancha, and the Spear, owned by McConnell & Spear. There is no development on these claims, but the outcroppings are similar to those of the Ulida group.

Copper Knife.—Located a quarter of a mile east of the Randolph racetrack; owners, W. T. Grant of Olancha and George McConnell of Independence. There is no development. The ledge outcrops about 800 feet, and shows a width of 10 feet. The ore is malachite.

Star.—Owned by W. A. Sanger & Son, Big Pine, Cal. The prospect is located at the base of the Ubehebe Mountain; the strike of the vein is north. There is a 60-foot cut, 6 feet deep, showing malachite. The ore outcrops 800 feet on the strike and shows a width of 60 feet.

Copper King.—It is located one mile west of the Star; owner, W. A. Sanger, Big Pine. The ledge shows on the surface a width of 100 feet and a length of 700 feet. There is a shaft 60 feet deep and a 20-foot drift, showing malachite. Idle.

Bluejay.—Owned by A. Mairs, of Independence. It is located on the east side of Saline Valley. The outcroppings show a ledge 60 feet wide, and may be traced 500 feet on the surface. There is a tunnel in 100 feet, a winze 35 feet deep, and a cross-cut 25 feet. The ore is malachite. Idle.

Anton & Pobst Claims.—These mines include five claims, located sixteen miles east of Keeler. The claims show outcroppings 100 feet wide, 800 feet in length, on the strike of the vein. The ore is chiefly malachite. There is a tunnel about 20 feet long, in good ore. Owners, John Anton and David Pobst, of Lone Pine, Cal.

Silver Hill.—This claim is located seven miles east of Independence, and one half mile from the Carson & Colorado Railroad; elevation, 4500 feet. Owner, J. C. Roeper, of Independence. There is a 70-foot tunnel, showing a 2½-foot vein

of malachite. The vein is a contact between granite and limestone. There is plenty of water for mining and reduction purposes. Developing.

Green Monster.—Owner, D. C. Riddell, of Gilroy, Cal. This is a continuation of the Silver Hill prospect. Development consists of a 300-foot tunnel and two cross-cuts, one 80 feet and the other 50 feet. Some good copper ore has been exposed.

Copper Tail.—J. C. Roeper, owner. This claim adjoins the Green Monster. It has a 40-foot shaft in the ore body. The ledge is 4 feet wide at the surface, but pinches at the bottom of the shaft.

Copper Point.—Owner, Max Fausel; located one mile northeast of the Green Monster. It has a 10-foot shaft in good ore. The vein shows a width of 2 feet, and an outcrop of about 500 feet on the surface. It is a contact vein between granite and limestone. The ore is malachite.

SAN BERNARDINO COUNTY.

Southeast of the terminus of the Sierra Nevada Mountain range is the vast expanse of the Mojave Desert, a rugged, desolate region, filled with mountain groups and ranges and characterized by a lack of almost every natural condition favorable to the operations of the prospector and miner, but one throughout which nature has lavishly distributed mineral riches in exceptional variety. Copper is one of the minerals thus widely distributed here, but its innumerable occurrences are generally, as far as explored, in quantities too small for commercial exploitation.

The largest portion of the Mojave Desert is included within the bounds of San Bernardino County, which is the largest county in the State. In the southwestern portion is a region unrivaled for beauty of fruits and flowers, fertile and charming valleys, and rich orange groves. Eastward from this Eden, for about 150 miles to the Colorado River, and northward for 75

miles to Inyo County, stretch the forbidding wastes that compose the most of San Bernardino County. It is in the little southwestern corner, where sheltered valleys open to the sea, that the population and developed wealth of the county are mainly concentrated, and it is by this corner that San Bernardino is chiefly known to the world.

The rest of the county is ruled by the miner. Prospectors have persistently explored its desolate and dangerous fastnesses for two generations and brought to general knowledge a mineral empire which capital is slowly possessing. There are few long well-defined belts or lodes, the multitudinous mineral-bearing veins coursing in all directions and being generally and irregularly distributed. There is a number of well-known mining districts scattered through the length and breadth of the county, where concentrations of mineral values have occasional important developments, and in which well-known mines flourish. The metalliferous ores carried by the veins are nearly always base. Gold is the dominant metal produced, but with a more favorable market for silver, the latter would probably assume first importance. In 1900 the gold output was \$247,949 and that of silver \$172,759. The county, however, displays a greater variety of mineral products than any other county in the State. In its northern portion are inexhaustible deposits of borax, the chief present mineral product of the county, the output of which in 1900, refined and crude, was valued at about \$1,000,000. The only tin mine of the State was operated in this county a few years ago. In this county is an exceptionally large and rich deposit of iron ore awaiting conditions favorable to its exploitation. One of the county's mineral products is turquoise, of which \$20,000 worth was mined in 1900. At Colton, Portland cement is made. Among other minerals are lead, salt, soda, antimony, sulphur, asbestos, onyx (aragonite), lime, granite, and marble. There has been much recent activity in various gold mining districts. The county is crossed by the main line of the Santa Fé Railroad, and branch roads reach different parts of the county. The Southern Pacific road runs through and near the southwestern portion.

While the occurrences of copper ore are frequent and widespread, there are yet but few mines or prospects worthy of particular note, or which attract present attention. But, as

with other resources of this great mineral field, there has been but a small beginning made in the prospecting and developing of the copper stored in these rugged wastes, though there is a great number of more or less promising copper claims showing superficial development.

The Copper World is the chief developed and producing mine in the county. It is equipped with a smelting plant. A few years ago considerable high-grade ore was shipped to Swansea from the Tiptop mine in the Lava Beds district, a silver mine in which bunches of rich copper ore were found along fault planes in the country rock. This ore, after concentration by jigging, yielded 33 per cent of copper and 15 ounces of silver per ton. The prevalent copper ores of this region are carbonates and oxides, and characteristically occur in irregularly-shaped masses, frequently in association with limestone formations. This county holds second rank as a copper producer. The output in 1900 was 1,920,000 pounds.

New York Group.—Contains nine claims, and lies five miles southwest of Manvel, in the northeastern part of the county. There is very little development and the ore is low grade. Owner, George Burch.

Von Trigor Group.—Six claims in the Exchequer mining district, Secs. 16 and 17, T. 11 N., R. 18 E., at the eastern side of the county. One of the claims is opened by a tunnel 30 feet long, all in ore. The ore is oxide, said to carry 7.6 per cent copper, \$3.96 in gold, and 2½ ounces in silver per ton. The gossan croppings are wide, with east and west strike. The claims are about two miles from the railroad, and the Colorado River is about eighteen miles east of the group. Elevation, 1800 feet. Owner, A. M. Williams, San Francisco.

Copper Mountain Mining Co.—This company, of which W. A. Cooper of San Bernardino is president, owns a group of ten claims in the southeastern part of the county, four and a half miles northeast of Victor and four miles east of Oro Grande. The Copper King claim shows gossan croppings 200 feet wide. The ore is sulphide, said to go 8 to 10 per cent copper and some carbonate. The hanging wall of the vein is limestone. The mine is opened by a shaft 200 feet deep on the vein, but no walls are exposed. This mine was first opened

twenty-eight years ago, and then closed down, in which condition it remained until recently, when it was re-opened and re-prospected. Of the other claims, Amazon No. 1 is opened by a shaft 60 feet deep, with a drift to the west 48 feet, and a drift to the north 45 feet. The strike of the vein on all the claims is east, with a northerly dip of about 60 degrees. The croppings are limonite. The vein is highly mineralized, with a fair grade of copper-bearing material interspersed. A heavy quartzite dike follows the vein on one side. The ore is reported to assay 10 per cent copper, and a fair amount of gold and silver. The Hecla mine is opened by three shafts, 30 to 40 feet deep. The Queen is opened by a cut 100 feet long, and from 15 to 25 feet wide, running diagonally across the formation, and exposing three different veins, one of which is 12 feet wide. The ore is sulphide. The other mines of the group show good copper indications. Further extensive developments are under consideration.

Rose Mine.—In Morongo district, 45 miles southeast of Victor; elevation, 7000 feet; strike northwest, with a dip of 30 degrees. The ore carries copper, gold, and silver. The vein is pockety, with walls of limestone. There is a shaft 1000 feet deep, a tunnel 500 feet long, and about 2000 feet of other developments. Reduction works are on the ground, and about 30 hands are employed. The total output of copper, gold, and silver has been about \$150,000. The property is worked as a gold mine primarily. The copper occurs in bunches in the vein and is sorted out and shipped to a smelter in relatively small quantities. The gold ore is reduced in a stamp mill. Owned by R. S. Grant, of Victor.

Camp Vera Group.—Contains thirty claims, all lying in the Morrow mining district, about twenty-five miles north of Barstow, and six miles northeast of Lane's Mills; elevation, 3725 feet. A mineralized belt consisting of ironstone rock, running through the county in a northeasterly direction, is partly covered by these claims. The belt varies in width from 50 to 500 feet and can be traced for ten miles. About twenty shafts, 10 to 60 feet deep, have been sunk near the belt. They all show ore containing considerable copper oxide, and other forms of copper mineralization. Open cuts have been made in other places near the belt, showing copper minerals. These

shafts and cuts are not on the mineralized belt, but are to the west of it a few hundred yards, and show that the copper deposits have a general dip toward the belt. A sample of six tons of ore was shipped to a smelter and is reported to have given returns of 18 per cent copper and \$4 in gold. Ironsides No. 1, of this group, is opened by a shaft 100 feet deep, which follows a streak of highly oxidized mineral, varying from 8 inches to 2 feet in width, which at the bottom of shaft shows an impregnation of copper in the form of a rather unique crystallization. The west wall is well defined, and is of a granitic character. The owner of the Camp Vera group is W. J. Rodgers, of Barstow.

Juanita.—This claim is in the Morrow mining district, twenty-six miles east of Johannesburg. Gossan croppings, varying from 2 to 12 feet in width, appear on this claim, and extend beyond its limits for a distance of over two miles. Beneath them the deposits of ore carrying copper are found to widen out as development proceeds. The hanging walls are granite, and the foot walls limestone. There are three veins about 30 feet apart covered by this claim. One shaft is 212 feet deep, two are 60 feet, and one is 40 feet deep. At 190 feet on the 212-foot shaft a cross-cut has been run, but it does not reach either wall. The ore is said to go 17 per cent in copper and \$3 in gold. The vein matter is of a talcose nature carrying copper sulphides throughout. Owner, Union Development Company of Boston.

Juanita Group.—Besides the Juanita mine, there are 141 other claims, constituting what is called the Juanita group. Among these claims, those having the most notable development are the Henrietta, Lookout, and Big Three. The Henrietta is opened by a shaft 52 feet deep, drift 28 feet long, and a winze from its end 10 feet deep. The character of the ore is oxide. The width is undetermined. The ore is said to assay 14 per cent copper, \$12 in gold and 2 ounces of silver to the ton. The Lookout claim is opened by a tunnel 30 feet long, striking a vein of carbonate ore about 3 feet in width, said to contain 32 per cent copper with no gold or silver. The foot wall is porphyry, with intrusions of limestone. There are eighty-six other shafts on the group, attaining depths of from 20 to 30 feet, showing veins of oxide ores from 2 to 40 feet in

width, said to average 7 per cent copper, \$4 in gold, and 3 ounces of silver. The Big Three claim is opened by a shaft 77 feet deep.

Copper World.—This, the only important producing copper mine in Southern California and the only one possessing reduction works, is in Clark Mountain, Clark mining district, thirty-seven miles northwest of Manvel, in the northeastern part of the county, and at an elevation of 5300 feet. The mine has displayed large bunches of oxide ore in porphyry and limestone formations, averaging 12 to 15 per cent in copper. The property has been opened by about 3000 feet of shaft and tunnels, the shaft reaching to a depth of 420 feet. At Valley Wells, five miles from the mine, is the reduction plant, which includes a 50-ton water-jacket furnace erected over two years ago and which has recently remained idle, owing both to a re-organization of the company and to the cost of transportation to and from the railroad at Manvel, supplies, including coal from New Mexico for the smelter, having to be hauled thirty miles by wagon. The railroad has been recently extended to within fifteen miles of the mine, and operations are again active. The mine is reported to produce 50 tons of smelting ore per day. The property has been operated by the Ivanpah Smelting Company of Los Angeles, which, it is stated, is to be succeeded by the Copper World Mining Company. It is stated that the total marketed product, amounting in value to about \$325,000, has more than paid the cost of development and plant. George D. Copeland, secretary, Wilcox Block, Los Angeles.

Lytle Creek Mine.—It lies twenty miles northwest of San Bernardino, and has been worked for the past twenty years. It contains bunches of high-grade copper ore.

The Peacock, or Lava Beds, Mining District.—One hundred miles east of San Bernardino, in the south-central part of the county. It contains some claims with gossan croppings undeveloped, that show indications of copper ores.

Ord Copper Group.—This group consists of twenty-three claims in Ord Mountain, fourteen miles south of Daggett. The strikes are nearly north and east. The deposits carry copper and gold, the former largely predominating, except in a few

places. The main vein is about three miles long and averages about 20 feet wide. The hanging wall is granite and the foot wall decomposed porphyry. The ore is copper carbonate and sulphide. A shaft 154 feet deep and a tunnel 400 feet long, with about 1000 feet of other development work, constitute the openings. Several of the claims are patented. Osborne & Drew, of Daggett, owners.

About forty miles northeast of Whitewater Station, on the Southern Pacific Railroad, in Riverside County, is a group of claims located in the Copper Mountains, a small group off the San Bernardino range, just west of the Twenty-nine Palms district. Owner, H. R. Hudspeth, of Los Angeles. The claims are on a lode crossing the principal lodes of the country. The deposit is between lime and porphyry. The copper is in the form of cuprite and chrysocolla. On the outcrop the mineralized zone is about 250 feet wide. The development consists of shafts, drifts, and cuts, and a tunnel 105 feet long.

About three miles north of Klinefelter Station is a mine owned by Lewis & Shafer, displaying a vein from 3 to 6 feet wide, between massive slate and granite and porphyry walls. The ore is stated to bear 20 per cent of copper associated with gold. A shaft has been sunk to a depth of 75 feet and a tunnel driven 50 feet, with about 100 feet of other development work.

RIVERSIDE COUNTY.

Riverside County comprises a wide strip of territory stretching across the desert region of the southeastern part of the State from the boundary at the Colorado River westward to a terminus on the Pacific slope. In this county is the San Bernardino range, which separates the Mojave and Colorado deserts, and the county thus includes portions of both these arid wastes. The western portion has become, with irrigation, one of the chief garden spots of Southern California, and the orange groves and floral wealth of this region have spread afar the fame of Riverside's glory.

Topographically, geologically, and mineralogically the desert region of Riverside resembles that of San Bernardino County to its north. Mineral wealth is similarly distributed, though the mining industry is of smaller relative importance. There has been much recent activity in the prospecting and development of several districts, chiefly in respect to gold. Among the varied minerals which are widely distributed over the county and which will be the basis of a great future mineral industry are silver, coal, salt, pottery clay, asbestos, marble, granite, etc. Copper is of wide occurrence in association with gold and silver ores, and a number of properties have received superficial development, but none have yet assumed importance as producers. The Southern Pacific Railroad crosses the county diagonally, giving fairly convenient access to several mineral districts. The southern boundary of the county runs through the depression known as Salton Lake, the lowest part of which is 275 feet below the level of the sea.

Orphan Boy Mines.—They are in the Palen Mountains, about two miles south of Packard's Well, Ironwood district. Elevation, 1850 feet. There are three claims in this group. The minerals are copper, gold, and silver, and the mineralized zone is about 100 feet wide, dipping southwardly. The country rock is porphyry. There are three open cuts and a shaft 8 feet deep revealing good ore. Assays are reported to show more than 30 per cent copper. The hanging wall is limestone or granular gypsum, dipping about 50 degrees. There is considerable massive epidote on these claims. Owner, P. W. McGrath, Los Angeles.

Palen Copper Mines.—Located on the west side of Palen Mountains, about ten miles east of Palen Wells. The character of the ore is copper, gold, and silver. The vein matter is about 50 feet wide. The country rock is quartzite and porphyry. Five shallow shafts have been excavated, which show good ore averaging about 30 per cent copper. There are two claims—The Copper-Silver Glance and The Ophir. The former is located on a spur of Palen Mountains in a cañon coming in from the east. It is about 250 feet above the creek bed and 2100 feet above sea-level. There are eight cuts and prospect holes in this spur, all yielding copper. The ledge

lies suitable for quarrying. Sandstone, quartzite, and granite are the country rock. Owner, H. G. Adams, Los Angeles.

Homestake Group.—There are five claims in this group, located on the east side of Palen Mountains, about eight miles northwest of McCoy Springs, at an elevation of 1600 to 2350 feet, and but three or four miles from the Orphan Boy and Ophir mines on the opposite side of the mountains. The five claims are on the same ledge, and carry copper, gold, and silver. The width of the ledge matter is 20 to 50 feet, and it yields copper-silver glance, azurite, and malachite. The development work consists of two shallow shafts and three open cuts. Owners, Adams & Creasinger, Los Angeles.

Mountain King Group.—Consists of three claims located on the east side of McCoy Mountains. The strike is northwest and southeast, and the dip northeast. The ore, which is azurite and malachite, contains copper, gold, and silver. The deposit is in ledge form, the vein matter being about 30 feet wide. A shaft 40 feet deep has been sunk, and four open cuts have been made, all revealing good ore. The country rock is porphyry and quartzite. The mine is easily accessible. Elevation, 1800 feet. Owners, Adams & Creasinger, Los Angeles.

Randolph & Hamilton Claims.—Consist of two groups and seven claims in Santa Maria Mountains. The deposits consist of copper and chromic iron, and some gold, at an elevation of about 1750 feet. A shaft 21 feet deep has been sunk and four or five cuts made. The copper value is about 7 or 8 per cent. Iron largely predominates. There is much limestone as country rock, and some porphyry. Owners, Randolph & Hamilton, Ehrenberg, Arizona.

Anderson Claims.—There are twenty-six claims in this group, located in the northern part of the county. The strike is northwest. The ore carries copper with a little silver, and the veins vary from 2 to 6 feet in width. The hanging wall is granite. A shaft 80 feet deep has been sunk and a tunnel 100 feet long driven, with considerable other development work in shafts, etc. Six men were employed. Anderson & Co., owners.

“Badger State” Group.—Ten claims located in the McCoy Mountains, about twenty miles west of the Colorado River. The ore contains copper, gold, and silver. There are a vast number of stringers from 6 inches to 4 feet wide. The walls are porphyry and limestone, granite being the country rock. There is also much iron in these claims. About 300 feet of development work has been done in open cuts, shallow shafts, etc., which reveal good ore. The present owner is S. P. Creasinger, of Los Angeles.

Fluor Spar Group.—This group of three claims is in the Palen Mountains, one mile southwest of Packard's Well, Ironwood district. The ledge matter is about 100 feet wide, and strikes northeast and southwest. The ore contains copper, gold, and silver. The country rock is largely porphyry and limestone. The copper represents azurite, malachite, etc., and some red oxide. There are two open cuts penetrating the mountains 20 feet or more. Elevation, 1800 feet. The group is owned by Jacob Berge. The mine contains much fluor spar, Iceland spar, and limpid quartz. The ore lies suitable for quarrying.

The Ironwood or McCoy Mountain district contains a highly mineralized zone of copper, silver, gold, and lead ores. High-grade sulphide deposits are known to exist, principally in the form of kidneys. Besides these, native copper is occasionally met with. The district is twenty-two miles from the Colorado River, and ore has been shipped by that route to reduction works.

In the Shadow Mountain district there are localities showing gold, copper, and lead ores. The copper ores are malachite and oxides

Vulture Crag.—The property is in the western part of the county, fourteen miles east of Capistrano, in Trabucco Cañon. There was not sufficient development to determine the extent of the deposit. In an 8-foot tunnel a ledge over 4 feet in width has been exposed. The ore is chiefly chalcopyrite, and the croppings may be traced for several miles. A. B. Joplin, of Santa Ana, owner.

SAN DIEGO COUNTY.

San Diego County stretches from the Pacific shore to the Colorado River, entirely across the southern end of California. The lower western slope, near the sea, is a populous, rich, and fertile region, famed for its climate, scenery, and productions. Back from the shore, mountains mark the eastern limit of fertility and beauty and the western limit of the expanse of arid mountain and valley composing the Colorado Desert and much the larger portion of the county's big area. In these mountains near the coast are various minerals, such as characterize the upper part of Lower California, and mineral wealth is widely distributed throughout the county eastward to the Colorado River. In the Colorado Desert this county holds the larger part of the valley traversed by the Southern Pacific Railroad, in which is found Salton Lake, that dry basin nearly 300 feet below sea-level. Rugged and desolate mountains fill most of the desert area, and among them the persistent prospector and the enterprising mining capitalist have established several important mining districts and developed some of the leading gold mines of the State. Copper minerals occur in association with the ores of other metals quite extensively throughout the county and especially in the eastern part near the Colorado River, but no copper deposits worthy of note as such have been developed in the desert region. The two prospects noted below are near the coast and are not to be associated with those of the arid region farther east.

Danes Lea Mining Co.—The mines of this company are located near the coast eight miles east of Encinitas, in T. 13 S., R. 3 W., S. B. M. The development consists of two shafts 200 feet apart and a tunnel. One of the shafts is down 280 feet and the other 100 feet. The shafts are sunk in the ore body, the ledge being about 3 feet wide in a porphyry formation. The ore is chalcopyrite, averaging a fair percentage of copper. A twelve-horse-power gasoline hoist has been installed. The company intend to erect a concentration plant as soon as the developments will justify the expenditure and to ship the concentrates to a smelter. In the group there are twenty claims, all showing copper in the croppings. W. H. Mackinnon of Encinitas is manager, and W. C. Harland of San Diego, president.

Barona Copper Claims.—This property is located thirty-five miles northeast of San Diego and twelve miles northeast of Lakeside, in T. 14 S., R. 1 E., S. B. M. The nearest point on the Cuyamaca Railroad is six miles distant. The development consists of two 25-foot shafts and two 25-foot cross-cuts in the ore body. The ledge, about 20 feet wide, is mineralized throughout, and copper croppings are exposed for about 150 feet in length on its strike and where developments have been performed. The ore is principally chalcopyrite and black oxide of copper. It assays about 8 per cent copper and carries \$1.50 in gold and 8 ounces of silver per ton. The ledge, a schistose quartz, is in granite. T. J. Daley, of San Diego, owner. The claim is idle.

In the eastern portion of the county bordering the Colorado River many small stringers of high-grade copper ore have been found. The development upon them, however, is very limited.

LOS ANGELES COUNTY.

With the exception of petroleum, mineral products play a relatively small part in the prosperity and greatness of Los Angeles County, which reaches eastward from the sea in the most favored portion of Southern California, which is far-famed for its climate and the wealth and beauty of its orange groves and luxuriant gardens, and which possesses, in the City of Los Angeles, the metropolis of this large section of the State. There are three rich oil-fields in the county, those of the City of Los Angeles, Whittier, and Puente. The petroleum output in 1900 was 1,722,887 barrels, and oil refineries produced a large amount of asphaltum.

North and east of the fertile valley regions of the county, in its northern and eastern parts, is a considerable portion of the Mojave Desert, similar in character to the desert regions of the adjoining counties of Kern, San Bernardino, and Riverside. In this region placer gold was mined before Marshall made his discovery in 1848, and ever since then placer mining operations have been continued on a small scale. A few valuable quartz mines have been developed. Copper was noted and a

little ore mined near Soledad Pass before the American occupation. The copper deposits which have received recent attention are all in the northeastern part of the county, near and northeast of Acton, in Soledad Pass, on the edge of the Mojave Desert.

Palm Development Co.—This company has superficially developed some claims located twenty-three miles northeast of Acton and three miles southeast of Little Rock Creek, in Sec. 30, T. 5 N., R. 10 W., S. B. M. The ore is found in deposits in a porphyritic dike, which averages 180 feet in width. The mineralized zone may be traced for one and a half miles. Three shafts have been sunk, 12, 70, and 125 feet deep respectively. While some ore was encountered in these shafts, they failed to show any defined ledge or continuous deposit. The ore is chiefly malachite and carries gold and silver. The mines have been leased to Messrs. Elliot & Leavitt, who have erected a leaching plant. It was their intention to extract the ore by surface workings, but in the midst of their operations the water-supply gave out and consequently work was suspended until more water could be obtained. E. M. Ross and Joseph H. Call, of Los Angeles, owners.

An extension of the claims of the Palm Development Company, on which no development has been made, is owned by William M. Van Dyke, of Los Angeles.

Free Cuba.—Located a half mile south of the Southern Pacific Railroad station at Acton. This mine was first worked about forty-five years ago, and abandoned. The old shaft has been cleaned out, and at the bottom, 200 feet from the surface, samples of native copper were found. A quartz ledge in granite is 23 feet wide, but the values are found in only about 5 feet of it. A hoisting plant was to be erected and the mine thoroughly prospected. Twelve men were employed. Ira L. Houser, of Acton, owner.

Mooney & Williams Claim.—Located two miles south of Acton. A crew was developing the property, and in the tunnel some fair copper ore had been encountered. The character of the ledge is similar to that of the Free Cuba. Further development is necessary to determine the extent of the deposit. Mooney & Williams, of Acton, owners.



FERRY BUILDING, SAN FRANCISCO, ONE HALF THE UPPER FLOOR OF WHICH IS OCCUPIED BY THE STATE MINING BUREAU

APPENDIX.

CALIFORNIA STATE MINING BUREAU.

This institution aims to be the chief source of reliable information about the mineral resources and mining industries of California.

It is encouraged in its work by the fact that its publications have been in such demand that large editions are soon exhausted. In fact, copies of them now command high prices in the market.

The publications, as soon as issued, find their way to the scientific, public, and private libraries of all countries.

STATE MINERALOGIST.

The California State Mining Bureau is under the supervision of Hon. Lewis M. Anbury, State Mineralogist. It is supported by legislative appropriations, and in some degree performs work similar to that of the geological surveys of other states; but its purposes and functions are mainly practical, the scientific work being clearly subordinate to the economic phases of the mineral field, as shown by the organic law governing the Bureau, which is as follows:

SEC. 4. It shall be the duty of said State Mineralogist to make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State. It shall be his duty: To collect statistics concerning the occurrence of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use; to make a collection of typical geological and mineralogical specimens, especially those of economic or commercial importance, such collection constituting the Museum of the State Mining Bureau; to provide a library of books, reports, drawings, bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the Library of the State Mining Bureau; to make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallur-

gical processes; to preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours; to maintain, in effect, a bureau of information concerning the mineral industries of this State, to consist of such collections and library, and to arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it, and to provide a custodian specially qualified to promote this purpose; to make a biennial report to the Board of Trustees of the Mining Bureau, setting forth the important results of his work, and to issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this State.

THE BULLETINS.

The field covered by the books issued under this title is shown in the list of publications. Each bulletin deals with only one phase of mining. Many of them are elaborately illustrated with engravings and maps. Only a nominal price is asked, in order that those who need them most may obtain a copy.

THE REGISTERS OF MINES.

The Registers of Mines form practically both a State and a County directory of the mines of California, each county being represented in a separate pamphlet. Those who wish to learn the essential facts about any particular mine are referred to them. The facts and figures are given in tabular form, and are accompanied by a topographical map of the county on a large scale, showing location of each mineral deposit, towns, railroads, roads, power lines, ditches, etc.

HOME OF THE BUREAU.

The Mining Bureau occupies the north half of the third floor of the Ferry Building, in San Francisco. All visitors and residents are invited to inspect the Museum, Library, and other rooms of the Bureau and gain a personal knowledge of its operations.

THE MUSEUM.

The Museum now contains over 16,000 specimens, carefully labeled and attractively arranged in showcases in a great, well-lighted hall, where they can be easily studied. The collection of ores from California mines is of course very extensive, and is supplemented by many cases of characteristic ores from the principal mining districts of the world. The educational value



MINERAL MUSEUM, CALIFORNIA STATE MINING BUREAU

of the exhibit is constantly increased by substituting the best specimens obtainable for those of less value.

These mineral collections are not only interesting, beautiful, and in every way attractive to the sightseers of all classes, but are also educational. They show to manufacturers, miners, capitalists, and others the character and quality of the economic minerals of the State, and where they are found. Plans have been formulated to extend the usefulness of the exhibit by special collections, such as one showing the chemical composition of minerals; another showing the mineralogical composition of the sedimentary, metamorphic, and igneous rocks of the State; the petroleum-bearing formations, ore bodies, and their country rocks, etc.

Besides the mineral specimens, there are many models, maps, photographs, and diagrams illustrating the modern practice of mining, milling, and concentrating, and the technology of the mineral industries. An educational series of specimens for high schools has been inaugurated, and new plans are being formulated that will make the Museum even more useful in the future than in the past. Its popularity is shown by the fact that over one hundred thousand visitors registered last year, while many failed to leave any record of their visit.

THE LIBRARY.

This is the mining reference library of the State, constantly consulted by mining men, and contains between 4000 and 5000 volumes of selected works, in addition to the numerous publications of the Bureau itself. On its shelves will be found reports on geology, mineralogy, mining, etc., published by states, governments, and individuals; the reports of scientific societies at home and abroad; encyclopædias, scientific papers, and magazines; mining publications; and the current literature on mining ever needed in a reference library. Manufacturers' catalogues of mining and milling machinery by California firms are kept on file. The Registers of Mines form an up-to-date directory for investor and manufacturer.

The librarian's desk is the general bureau of information, where visitors from all parts of the world are ever seeking information about all parts of California.



LIBRARY AND FREE READING ROOM, CALIFORNIA STATE MINING BUREAU

READING-ROOM.

This is a part of the Library Department and is supplied with over one hundred current publications. Visitors will find here various California papers and leading mining journals from all over the world.

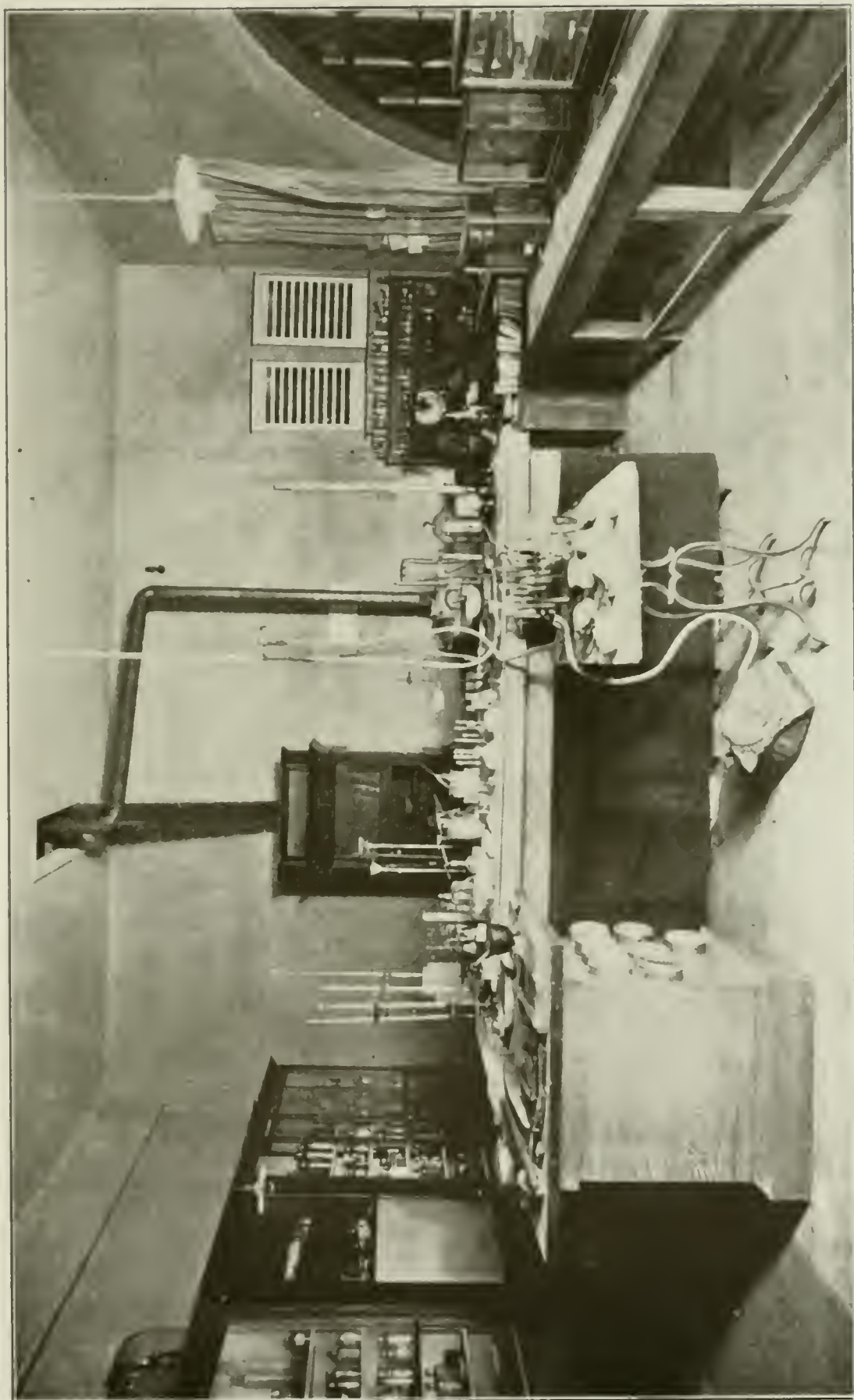
The Library and Reading-Room are open to the public from 9 A. M. to 5 P. M. daily, except Sundays and holidays, and from 9 A. M. to 12 M. on Saturdays.

THE LABORATORY.

This department identifies for the prospector the minerals which he finds, and tells him the nature of the wall rocks or dikes that he may encounter in his workings; but this department *does not* do assaying nor compete with private assayers. The presence of minerals is determined, but not the percentage present. No charges for this service are made to any resident of the State. Many of the inquiries made of this department have brought capital to the development of new districts. Many technical questions have been asked and answered as to the best chemical and mechanical processes of handling ores and raw material. The laboratory is well equipped.

THE DRAUGHTING-ROOM.

In this room are prepared scores of maps, from the small ones filling only a part of a page, to the largest County and State maps; and the numerous illustrations, other than photographs, that are constantly being required for the Bulletins and Registers of Mines. In this room, also, will be found a very complete collection of maps of all kinds relating to the industries of the State, and one of the important duties of the department is to make such additions and corrections as will keep the maps up to date. The seeker after information inquires here if he wishes to know about the geology or topography of any district; about the locations of the new camps, or positions of old or abandoned ones; about railroads, stage roads, and trails; or about the working drawings of anything connected with mining.



LABORATORY, CALIFORNIA STATE MINING BUREAU

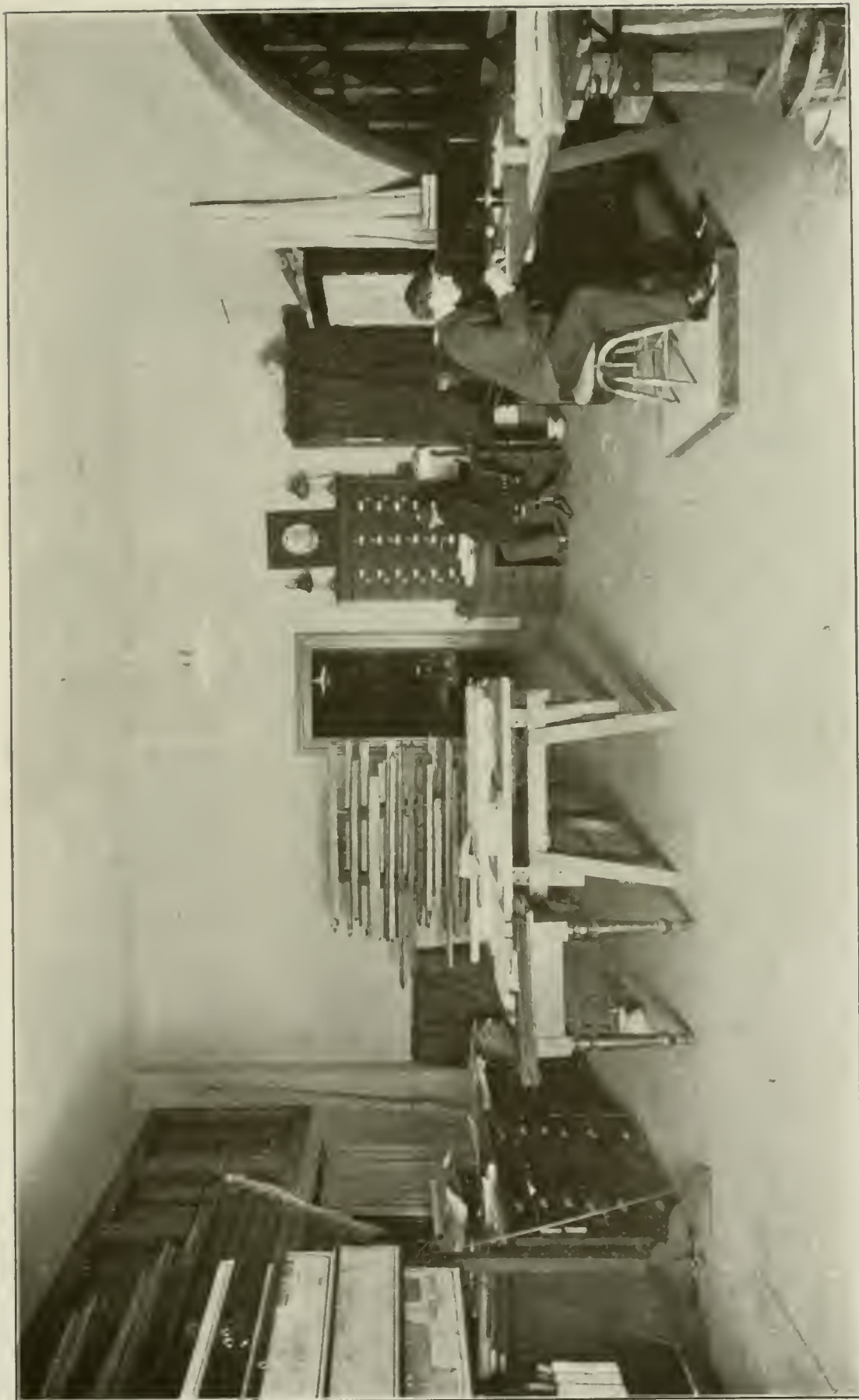
MINERAL STATISTICS.

One of the features of this institution is its mineral statistics. Their annual compilation by the State Mining Bureau began in 1893. No other State in the Union attempts so elaborate a record, expends so much labor and money on its compilation, or secures so accurate a one.

The State Mining Bureau keeps a careful, up-to-date, and reliable but confidential register of every producing mine, mine-owner, and mineral industry in the State. From them are secured, under pledge of secrecy, reports of output, etc., and all other available sources of information are used in checking, verifying, and supplementing the information so gained. This information is published in an annual tabulated, statistical, single-sheet bulletin, showing the mineral production by both substances and counties.

TOTAL GOLD PRODUCT OF CALIFORNIA—1848-1904.

1848 \$245,301	1868 \$17,555,867	1888 \$12,750,000
1849 10,151,360	1869 18,229,044	1889 11,212,913
1850 41,273,106	1870 17,458,133	1890 12,309,793
1851 75,938,232	1871 17,477,885	1891 12,728,869
1852 81,294,700	1872 15,482,194	1892 12,571,900
1853 67,613,487	1873 15,019,210	1893. ... 12,422,811
1854 69,433,931	1874 17,264,836	1894. ... 13,923,281
1855 55,485,395	1875 16,876,009	1895 15,334,317
1856 57,509,411	1876 15,610,723	1896 17,181,562
1857 43,628,172	1877 16,501,268	1897 15,871,401
1858 46,591,140	1878 18,839,141	1898 15,906,478
1859 45,846,599	1879 19,626,654	1899 15,336,031
1860 44,095,163	1880 20,030,761	1900 15,863,355
1861 41,884,995	1881 19,223,155	1901 16,989,044
1862 38,854,668	1882 17,146,416	1902 16,910,320
1863 23,501,736	1883 24,316,873	1903 16,471,264
1864 24,071,423	1884 13,600,000	1904 19,109,600
1865 17,930,858	1885 12,661,044	
1866 17,123,867	1886 14,716,506	
1867 18,265,452	1887 13,588,614	
		Total .. \$1,414,856,268



DRAFTING DEPARTMENT, CALIFORNIA STATE MINING BUREAU

COUNTY RANK IN GOLD PRODUCT IN 1904.

While gold is still the leading mining product, its yield no longer puts the greatest gold-producing county in the first place. The petroleum of Kern County and the copper of Shasta give them precedence. Gold is more widely distributed than any other substance thus far mined in California; 34 counties out of the 57 in the State showing a gold yield in 1904, and it is known to exist in several others. The order in rank of the counties of the State, in the production of gold alone, is at present as follows:

1. Nevada	\$3,130,304	20. Yuba	\$139,528
2. Amador	2,060,573	21. Lassen	116,993
3. Butte	1,932,552	22. Madera	75,303
4. Calaveras	1,789,184	23. Humboldt	62,061
5. Tuolumne	1,563,907	24. Stanislaus	50,000
6. Kern	1,426,523	25. Los Angeles	12,402
7. Shasta	1,031,429	26. Fresno	7,809
8. Siskiyou	892,685	27. Riverside	7,488
9. Placer	778,355	28. Del Norte	7,399
10. San Bernardino	595,828	29. Monterey	6,941
11. Trinity	574,814	30. Alpine	4,827
12. El Dorado	474,994	31. Ventura	2,700
13. Mariposa	429,771	32. Tulare	1,100
14. Sacramento	419,287	33. San Luis Obispo	630
15. Sierra	374,763	34. Mendocino	75
16. San Diego	334,697	Unapportioned	114,835
17. Plumas	270,439		
18. Mono	268,930	Total	\$19,109,600
19. Inyo	150,474		

TOTAL MINERAL PRODUCT OF CALIFORNIA FOR 1904.

The following table shows the yield and value of mineral substances of California for 1904, as per returns received at the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

	Quantity.	Value.
Asbestos	10 tons	\$162
Asphalt	56,187 "	672,910
Bismuth	20 "	2,400
Bituminous Rock	45,280 "	175,680
Borax (Crude)	45,647 "	698,810
Cement	969,538 bbls.	1,539,807
Chrome	123 tons	1,845
Clays (Brick)	281,750 M	1,994,740
Clays (Pottery)	84,149 tons	81,952
Coal	79,062 "	376,494
Copper	29,974,154 lbs.	3,969,995
Fuller's Earth	500 tons	9,500
Glass Sand	10,004 "	12,276
Gold .....	.....	19,109,600
Granite	520,687 cu. ft.	467,472
Infusorial Earth	6,950 tons	112,282
Gypsum	8,350 "	56,592
Lead	124,000 lbs.	5,270
Lithia Mica	641 tons	25,000
Lime	579,451 bbls.	571,749
Limestone	40,207 tons	87,207
Macadam	532,690 "	414,668
Manganese	60 "	900
Magnesite (Crude)	2,850 "	9,298
Marble	55,401 cu. ft.	94,208
Mica	50 tons	3,000
Mineral Paint	270 "	1,985
Mineral Water	2,430,320 gals.	496,946
Natural Gas ...	144,437 M cu. ft.	91,035
Paving Blocks	3,977 M	161,752
Petroleum	29,736,003 bbls.	8,317,809
Platinum .....	.....	1,849
Pyrites	15,043 tons	62,992
Quicksilver	28,876 flasks	1,086,323
Rubble ...	1,764,208 tons	1,227,209
Salt	95,968 "	187,300
Sandstone	365,487 cu. ft.	567,181
Serpentine	200 tons	2,310
Soda	12,000 "	18,000
Silver .....	..... (Com. value)	873,525
Slate ..	6,000 squares	50,000
Soapstone	228 tons	2,315
Tourmaline .....	.....	65,000
Other Gems .....	.....	71,000
Total value .....	.....	\$43,778,348

MINING BUREAU PUBLICATIONS.

Publications of this Bureau will be sent on receipt of the requisite amount and postage. Only stamps, coin, or money orders will be accepted in payment. (*All publications not mentioned are exhausted.*)

Attention is respectfully called to that portion of Section 8, amendment to the Mining Bureau Act, approved March 10, 1903, which states: "The Board (Board of Trustees) is hereby empowered to fix a price upon, and to dispose of to the public, at such price, any and all publications of the Bureau, including reports, bulletins, maps, registers, etc. The sum derived from such disposition must be accounted for and used as a revolving printing and publishing fund for other reports, bulletins, maps, registers, etc. The prices fixed must approximate the actual cost of printing and issuing the respective reports, bulletins, maps, registers, etc., without reference to the cost of obtaining and preparing the information embraced therein."

	Price.	Postage.
Report XI—1892, First Biennial	\$1 00	\$0 15
Report XIII—1896, Third Biennial.....	1 00	20
Bulletin No. 6—"Gold Mill Practices in California" (3d edition).....	50	04
Bulletin No. 9—"Mine Drainage, Pumps, etc.," bound	60	08
Bulletin No. 15—"Map of Oil City Oil Fields, Fresno County, Cal."	05	02
Bulletin No. 16—"Genesis of Petroleum and Asphaltum in California" (3d edition).....	30	03
Bulletin No. 23—"Copper Resources of California".....	50	12
Bulletin No. 24—"Saline Deposits of California".....	50	10
Bulletin No. 27—"Quicksilver Resources of California"	75	08
Bulletin No. 30—"Bibliography Relating to the Geology, Paleontology, and Mineral Resources of California, in- cluding List of Maps"	50	10
Bulletin No. 31—"Chemical Analyses of California Pe- troleum" .....	..	02
Bulletin No. 32—"Production and Use of California Pe- troleum"	75	08
Bulletin No. 36—"Gold Dredging in California"	50	06
Bulletin No. 37—"Gems and Jewelers' Materials of Cali- fornia"	50	06
Bulletin No. 39—"Mineral Production of California"— 1904 .....	..	02
Bulletin No. 40—"Mineral Production of California for 18 Years" .....	..	02
Bulletin No. 41—"Mines and Minerals of California"....	..	04
Reconnaissance of the Colorado Desert Mining District	15	02
Map of Desert Portion Southern California.....	10	02
Map of Mother Lode	05	02
Gold Production in California from 1848 to 1905 .....	..	02
Register of Mines, with Map, Plumas County.	25	08

	Price	Postage.
Register of Mines, with Map, Siskiyou County	\$0 25	\$0 08
Register of Mines, with Map, Trinity County	25	08
Register of Mines, with Map, Lake County	25	08
Register of Mines, with Map, Nevada County	25	08
Register of Mines, with Map, Placer County	25	08
Register of Mines, with Map, El Dorado County	25	08
Register of Mines, with Map, Inyo County	25	08
Register of Mines, with Map, Shasta County	25	08
Register of Mines, with Map, San Bernardino County	25	08
Register of Mines, with Map, San Diego County	25	08
Register of Mines, with Map, Sierra County	25	08
Register of Mines, with Map, Amador County	25	08
Register of Mines, with Map, Tnolunne County	25	08
Register of Mines, with Map, Butte County	25	08
Register of Mines, with Map, Mariposa County	25	08
Register of Mines, with Map, Kern County	25	08
Register of Mines, with Map, Yuba County	25	08
Register of Oil Wells, with Map, Los Angeles City	35	02
Mineral and Relief Map of California	25	05

IN PREPARATION :

Map and Register of Santa Barbara County.

Samples (limited to three at one time) of any mineral found in the State may be sent to the Bureau for identification, and the same will be classified free of charge. It must be understood, however, that *no assays or quantitative determinations will be made*. Samples should be in lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc. A *letter* should accompany sample, and a *stamp* should be inclosed for reply.

INDEX.

	PAGE		PAGE
ALAMEDA COUNTY—Description	144	CALAVERAS COUNTY—CONTINUED.	
Mines in—		Mines and claims in—	
Alma	144	San Domingo Creek	198
Leona Heights	144	Satellite	194
ALPINE COUNTY—Description	199	Star and Excelsior	197
Early discovery in	23	Union	189
Mines and claims in—		CALIFORNIA COPPER COMPANY	218
Leviathan	199	CALIFORNIA STATE MINING	
Morning Star	199	BUREAU	263
Rogers, "Uncle Billy," discovery	199	CALIFORNIA COPPER PRODUC-	
Stella	199	TION—In 1901	9
AMADOR COUNTY—Description	182	By counties since 1894	18
Mines and claims in—		By counties in 1901	20
Buena Vista	186	For fourteen years, graphic	19
Bull Run	186	CALIFORNIA MINERAL STATIS-	
Chaparral	186	TICS	270, 272, 273
Copper Hill	186	CAMPO SECO, CALAVERAS COUN-	
Forest Home Mining Co.	187	TY—Mines	194
Ione City	186	Lode	188
Mineral City	187	COAST RANGE DEPOSITS	97
Moon	185	COLORADO—Copper product of	21
Mutual Life Insurance Co.	187	COLORADO DESERT	259
Newton	183	COLUSA COUNTY—Description	129
Russel	186	Mines and claims in—	
Thayer	186	Blackbird	132
Whittle, W. H.	187	Gem	132
APPENDIX	263	Gray Eagle	132
ARIZONA—Copper product of	21	Lion	134
BELT, COPPER, SIESTA COUNTY	43	Mark Hanna Oil Co.	131
Geology of	53	Pacific	133
BELT, SIERRA NEVADA COPPER	119	Ruby King Co.	133
BROWNE, J. ROSS—Report on copper	24	CONDITION OF COPPER INDUSTRY	9
BULLY HILL MINE—Description	75	COPPER KING MINE	226
Geology of	60, 75	COPPER ORES OF CALIFORNIA	12
History of	31	COPPEROPOLIS LODGE, CALA-	
BUREAU, STATE MINING	263	VERAS COUNTY	188
CALAVERAS COUNTY—Description	188	COPPEROPOLIS, MINES AT	189
Mines and claims in—		COPPER WORLD MINE	254
Caledonian	198	DEATH VALLEY	213
Collier	197	DEL NORTE COUNTY—Description	111
Campo Seco	191	Geology of copper deposits	112
De Martini ranch	198	Low Divide district, map of	113
Eagle	197	Mines and claims in—	
Heckla	191	Alameda	115
McCarty, Jackson	198	Alta	114
Josephine	197	Aurora	114
Keystone	189	Bear's Nest	115
Meteor	196	Call	115
Messenger ranch	198	Copper Hill	111
Napoleon	196	Del Norte	116
Pattee ranch	198	Doctor Rock	116
Penn Chemical Works	191	Eva	115
Pool, A. S.	198	Express	114

	PAGE.		PAGE.
DEL NORTE COUNTY—CONTINUED.		GEOLOGY OF SHASTA COUNTY	
Mines and claims in—		COPPER BELT.....	53
Five Diamonds.....	115	GLENN COUNTY—Description.....	129
Higgins Mountain.....	116	Mines and claims in—	
Keystone.....	115	Black Buttes.....	132
Mammoth.....	114	Hudibras.....	131
McKee.....	115	Knight, H. D.....	132
Monkey Creek.....	116	Lehorn, A. W.....	132
Occidental.....	111	Peckville, claims at.....	132
Occidental No. 2.....	114	St. John Development Co.....	132
Prudential.....	116	HISTORICAL NOTES—General.....	23
Tuesday Morning.....	116	Bully Hill Mine.....	31
Union.....	111	Mountain Copper Mine.....	31
EL DORADO COUNTY—Description.....	171	Shasta County, copper.....	31
Mines and claims in—		HUMBOLDT COUNTY—Description.....	126
Agara.....	180	Mines and claims in—	
Alabaster Cave.....	176	Crimson.....	129
Arizona.....	180	La Perine.....	128
Barklege & Miller.....	178	Rainbow.....	128
Bob.....	181	Red Cap.....	127
Boston.....	180	Red Lasseck.....	128
Bryant ranch.....	180	IDAHO—Copper product of.....	21
Cambrian.....	177	INYO COUNTY—Description.....	213
Contraband Tunnel.....	178	Mines and claims in—	
Copper Chief.....	180	Anton & Probst.....	248
Cosumnes.....	178	Bluejay.....	248
Dr. Wren.....	180	Copper King.....	248
Homestead.....	177	Copper Knife.....	248
Kelley Bros.....	176	Copper Point.....	249
Lilyama.....	176	Copper Tail.....	249
Noonday.....	182	Dodd's Springs.....	246
Oest, Peter.....	182	Eureka.....	246
Pioneer.....	177	Green Monster.....	249
Rip and Tear.....	181	Kingman.....	245
Robert.....	180	McConnell & Spear.....	248
Woods, W. W.....	181	Navajo Chief.....	245
EXPORTS, FROM SAN FRANCISCO,		Silver Hill.....	248
1862-1867.....	29	Star.....	248
1861-1874.....	30	Trail.....	246
FOOTHILL BELT, SIERRA NEVADA.....	149	Ubelibe.....	245
FRESNO COUNTY—Description.....	224	Ulida.....	246
Mines and claims in—		Wisconsin.....	245
Anderson & Gist.....	233	KERN COUNTY—Description.....	237
Black Mountain.....	230	Mines and claims in—	
Bodders & Co.....	233	Gallow Glass.....	241
Buck's Peak.....	232	Greenback.....	238
Copper King.....	226	Hooper, J. L.....	241
Fresno.....	226	Maltby, A. J.....	240
Grubstake.....	230	Manning, J. R.....	241
Happy Camp.....	232	Spa and Bonanza.....	241
Hildebrand, A. L.....	232	KEYSTONE MINE, CALAVERAS	
Hinkle Bros.....	233	COUNTY.....	189
Imperial Copper M. Co.....	225	LAKE COUNTY—Description.....	138
Kanawy & Sons.....	233	Mines and claims in—	
Mount Sterling.....	230	Christianson ranch.....	139
Painter.....	225	Copper Prince M. Co.....	138
Sunset.....	232	Poc.....	139
Terrill.....	233	LAKE SUPERIOR—Copper product of.....	21
Wabash.....	230	LASSEN COUNTY—Copper in.....	150
Wineberger, Henry.....	232		

	PAGE.		PAGE.
LOS ANGELES COUNTY—Description		MERCED COUNTY—Claims in—	
tion	260	José	146
Historical reference	23	Victor Bonanza	146
Mines and claims in		MODOC COUNTY—Copper in	150
Free Cuba	261	MOJAVE DESERT	249
Mooney & Williams	261	MONO COUNTY—Description	242
Palm Dev. Co.	261	Mines and claims in—	
Van Dyke, W. M.	261	Goleta Cons.	243
MADERA COUNTY—Description	217	Santiago, et al.	243
Mines and claims in—		MONTANA—Copper product of.	21
Adobe ranch	222	MOTHER LODE—Relation to copper	
Big Chief	222	bell	201
Buchanan	217	MOUNT WHITNEY	243
California Copper Co.	218	MOUNTAIN COPPER MINE	
Copper Queen	218	Analysis of matte	65
Krohn, Mrs. L.	222	Description	66
Minaret Mountains, claims	217	Geology of	62
Questo	220	Historical	31
Reed	222	Production of	73
Ward, C. M.	222	NAPA COUNTY—Description	139
Ward J. H.	222	Mines and claims in—	
MARIN COUNTY—Description	113	Napa Copper	110
Mines and claims in		Search	110
Bolinas Copper M. Co.	113	NAPOLÉON MINE, CALAVERAS	
Pike Gulch M. Co.	143	COUNTY	196
Union Copper M. Co.	143	NEVADA—Copper product of.	21
MARIPOSA COUNTY—Description	203	NEVADA COUNTY—Description	162
Hornitos copper bell	213	Mines and claims in—	
Mines and claims in—		Arkansas Traveler	167
Barrella	215	Binger's ranch	170
Bruschi	215	Bitner, C. C.	167
Castignetto, Daniel	215	California G. & C. Co.	167
Cavan M. & M. Co.	206	Edison	171
Commissiona, G.	216	Green Lead	167
Copper Queen	216	Hibber, Henry	167
Coppertown M. & S. Co.	213	Mineral Hill M. & S. Co.	167
Cornett	212	Nickerson ranch	166
Dias, John	213	Roberts, Daniel	170
Farrari Bros.	215	Spenceville Copper Mine	163
Great Northern	209	Worthley, E. T.	171
Green Mountain	204	NEW MEXICO—Copper product of	21
Halstead ranch	215	NEWTON MINE, AMADOR COUNTY	183
Heiser, George	216	ORES, COPPER, OF CALIFORNIA	12
La Victoria	213	ORE DEPOSITS OF SHASTA COUN-	
Lone Tree	206	TY—Geology of	57
Lone Tree	213	OWENS VALLEY	241
Minarets, claims near	216	PACIFIC COAST SMELTING WORKS	228
Pocahontas	209	PENN CHEMICAL WORKS	191
Rihn's ranch	215	PLACER COUNTY—Description	172
Ward, claims	216	Mines and claims in—	
White Rock Copper King	210	Algol	173
MENDOCINO COUNTY—Description	131	Big Pine	174
Mines and claims in—		Reed Estate	171
McGimpsey	136	Valley View	171
Native Copper	135	PLUMAS COUNTY—Description	152
Ogle	135	Mines and claims in—	
Pieta	136	Boyden, W. P.	158
Redwood Copper Queen	136	Blue Bell M. Co.	155
Red Mountain	135	Cosmopolitan	155
Thomas	135	Davis	158
		Duncan	156

	PAGE.		PAGE.
PLUMAS COUNTY—CONTINUED.		SAN BERNARDINO COUNTY—CON-	
Mines and claims in—		TINUED.	
Engle Copper M. Co.	158	Mines and claims in—	
Engle Bros.	158	Peacock district	251
Husselman & Shaw	159	Rose	252
Little Gem	155	Tiptop	251
Mammoth	160	Von Trigor	251
Montgomery	151	SAN DIEGO COUNTY—Description.	259
Polar Star	151	Mines and claims in—	
Reward	155	Barona	260
Williams	155	Danes, Lea	259
PRICE OF COPPER, AVERAGE AN-		SAN LUIS OBISPO COUNTY—Claims	
NUAL	21	in—	
PRICE, THOMAS, HISTORICAL		Guadalupe	148
PAPER	26	Guerro	148
PRODUCTION, COPPER, IN CALI-		Los Osos	147
FORNIA—		Prodigal Son	147
Annual since 1882	17	Refugio	148
By counties in 1901	20	Schneider & McCles	148
By counties since 1894	18	Sky Scraper	148
For fourteen years, graphic	18	Tiptop	147
Relative	20, 21	SHASTA COUNTY—Copper belt of	43
PRODUCTION, COPPER, U. S. BY		Copper product of	42
STATES	21	Description	39
PRODUCTION, MOUNTAIN COP-		Historical	31
PER MINE	73	Mineral product	42
PRODUCTION, SHASTA COUNTY		Mines and claims in—	
MINERAL	42	Afterthought	92
PUBLICATIONS, STATE MINING		Arps	96
BUREAU	274	Balaklala	84
RIVERSIDE COUNTY—Description	255	Black Diamond	94
Mines and claims in—		Bohematosh	88
Anderson	257	Cowboy	91
Badger State	258	Doedollis	92
Fluor Spar	258	Donkey	93
Homestake	257	Excelsior	95
Ironwood district	258	Ferguson & Limbough	90
McCoy Mountain district	258	Friday & Lowden	86
Mountain King	257	Galvin	81
Orphan Boy	256	Giant Consolidated	81
Palen	256	Golinsky	90
Randolph & Hamilton	257	Graves	90
Shadow Mountain district	258	Great Verde	90
Vulture Crag	258	Gregory & Whalen	90
SAN BENITO COUNTY—Claim in—		Hartford	93
Lewis Creek	146	Jaegel	95
SAN BERNARDINO COUNTY—De-		Jumping-Jack	81
scription	249	Keystone	90
Mines and claims in—		King	81
Camp Vera	252	King Copper	81
Copper Mountain M. Co.	251	Kosk Creek	93
Copper World	254	Loraine	82
Hudspeth, H. R.	255	Mammoth	87
Juanita	253	Mayflower	88
Juanita Group	253	McClure	96
Lava Beds district	254	Memorial	95
Lewis & Shafer	255	Michigan	95
Lytle Creek	254	Mineral Mountain	81
New York	251	Mount Shasta Gold Mines Corp'n	51
Ord	251	Northern Light	95

	PAGE.		PAGE.
SHASTA COUNTY—CONTINUED.		SMELTERS—CONTINUED.	
Mines and claims in—		In California, 1868	29
Ohio Consolidated	86	Mountain Copper Co.	70
Roseman	94	Pacific Coast Smelting and Refining	
Schmidt	93	Works	228
Shasta King	82	SONOMA COUNTY—Description	110
Shasta May Blossom	92	Mines and claims in—	
Spread Eagle	82	Altamont	142
Stowell	82	Archer Tract	111
Sugar Loaf	81	Baby Jack	112
Summit	88	Grizzly	112
United Copper	82	Healdsburg Lode	141
Waters	82	Wall Tract	111
Webster Consolidated	82	Ward Tract	112
Ydalpom	96	SOUTH DAKOTA—Copper product of	21
SIERRA COUNTY—Description	152	SOUTHERN AND EASTERN DE-	
Mines and claims in—		POSITS	212
Antelope Neck	161	SPENCE MINERAL CO	163
Bassett's Pride	161	SPENCEVILLE COPPER MINE	163
Hapgood & Miller	161	STATISTICS—Average annual price	21
Poker Flat district	161	California mineral	270, 272, 273
Zuver, G.	161	Copper, of California	
SIERRA NEVADA BELT	149	By counties in 1901	20
SISKIYOU COUNTY—Description	102	By counties since 1894	18
Mines and claims in—		For fourteen years, graphic	19
August Flower	105	Since 1882	17
Blue Ledge	108	Exports copper, from San Francisco,	
Bonanza	105	1861-74	30
Bonanza	107	Exports copper ore, from San Fran-	
Bunnell	107	cisco, 1862-67	29
Clear Creek	109	Shasta County, 1894-1900	42
Copper Queen	105	United States, by states	
Fortuna	105	In 1885, 1890, 1895, 1900	21
Hidden Treasure	105	In 1900	22
Hummer	101	TEHAMA COUNTY—Description	129
Huntley	105	Mines and claims in—	
Indian Creek	109	Elder Creek	131
Klamath	109	Kestner & Thompson	131
Lytle	106	Perine, L. E.	131
Monarch	106	White Bluff	131
Nigger Creek	109	TRINITY COPPER CO.	50, 81, 82
Plutus	105	TRINITY COUNTY—Description	117
Polar Bear	106	Mines and claims in—	
Preston Peak	110	Black Palangus	121
Rader	106	Cinderella	120
Rainbow	107	Cold Creek	118
Rothkoph	106	Copper Bullion	126
Schnider	107	Copper Queen	120
Solomon	105	Copper Queen	124
Thanksgiving	106	Crown Point	122
Turner	106	Eureka	122
Unexpected	107	Fortuna	122
Yellow Buttes	107	Granite	120
SOLEDAD PASS—Copper at	23	Iron Mountain	124
SMELTERS		Island Mountain	121
Bully Hill Shasta County	78	Jackson & Carter	122
California Copper Co., Madeta		Lambert	119
County	220	Le Blanc	122
Copper King Fresno County	228	Lone Pine	119
Early smelters	20	Maddox	119

	PAGE.		PAGE.
TRINITY COUNTY—CONTINUED.		TUOLUMNE COUNTY—CONTINUED.	
Mines and claims in—		Mines and claims in—	
Maitland	122	Chinese Camp, claims at	201
Murphy	119	Donahue ranch	202
Nonpareil	120	Don Pedro district	202
Pattie	119	Kohl ranch	201
Shoemaker	122	Mackay ranch	201
Vine Oak	119	Moccasin Creek, copper at	201
TULARE COUNTY—Description	233	Oak Hill	202
Mines and claims in—		Olson ranch	201
Barber	236	Shell ranch	201
Dewey	236	Washington	202
Grider, W. F.	234	UNION MINE, CALAVERAS COUN-	
Keller, C. W.	236	TY	189
Powell, W. F.	234	UTAH—Copper product of	21
Cloudy River cañon claims	236	WYOMING—Copper product of	21
Copper Mountain M. Co.	236	YUBA COUNTY—Description	171
TUOLUMNE COUNTY—Description	200	Copper in—	
Mines and claims in—		Brady ranch	172
Blanchard ranch	202	Dempsey ranch	171

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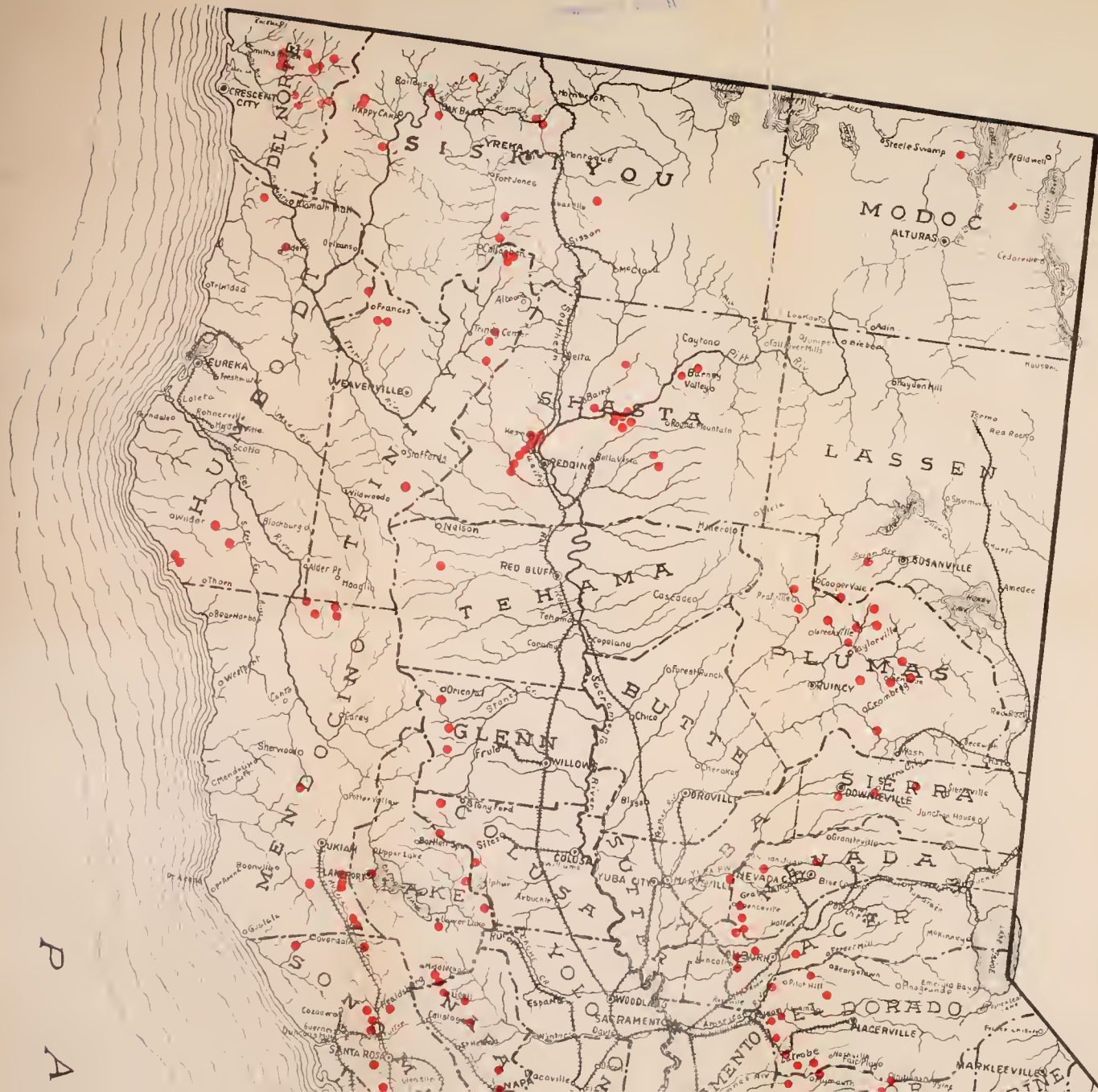
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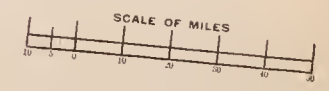
MAP OF
CALIFORNIA
Showing the Approximate Location
of the Principal
COPPER DEPOSITS
OF THE STATE

To accompany Bulletin No. 23, "The Copper Resources of California,"
ISSUED BY THE

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LEWIS E. AUBURY, STATE MINERALOGIST,
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